An Outline of GENERAL PSYCHOLOGY

REVISED EDITION

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PREFACE TO REVISED EDITION

The revised edition of this Outline is unchanged in point of view, scope, and arrangement of material as described below. Certain passages have been rewritten for clearness and exactness, specific factual material has been added, and most important, this edition includes references to thirteen new textbooks and revisions that have been published since this book was first issued [illegible] than a year ago.

This Outline is a condensed guide to the subject of psychology and presupposes additional reading, either preceding or accompanying its study. Specific references are included at the beginning of each chapter to facilitate the selection of readings. Objective tests will be found immediately following the index.

The book contains facts and generalizations important to psychology as a general science. Contributions to this general knowledge are included from social, racial, animal, abnormal, and other special fields of psychology. Dates and names of investigators are given to show the historical development of the science.

For the convenience of the reader, the Outline is divided into four parts. The introduction sketches briefly the historical background out of which modern scientific psychology has emerged. Suggestions for the efficient study of general psychology also are included. Elemental facts and generalizations are considered in Part A, and a more detailed discussion follows in Part B where psychological activity is studied more as it would be observed under the natural conditions of life. Part C is an intensive study of the organism in its integrative aspects.

While Parts A, B, and C are arranged in omnibus fashion, and offer a genetic development of knowledge, they have distinctive uses according to the purposes and levels of study. Part A is an introduction to general theory and facts such as might be used, with the accompanying references, in a one term or semester course in general psychology. Part B, likewise, could be used independently where the emphasis is upon application and interest is in detailed facts of objective and group observation. Conscious activity is neglected in this part. Part C taken alone, with a review of chapters I and II, offers material for a more advanced study of the organism's contribution to its own activity. The book as a whole is a review, which can be made as extensive as the student wishes through reference reading, of what is generally recognized as the field of general psychology.

An adequate system of psychological facts and generalizations is unattainable at present. The point of view of this book is dynamic; psychology is viewed as a study of organismic integrative activity.

D. F.—E. R. H.

May, 1937.

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TABULATED BIBLIOGRAPHY OF STANDARD TEXTBOOKS ON GENERAL PSYCHOLOGY

(See next two pages)

The following list gives the author, title, and publisher of the standard textbooks referred to in the table on the next two pages.

Bills, *General Experimental Psychology*, Longmans, 1934.

Boring, et al, *Introduction to Psychology*, Wiley, 1939.

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Woodworth, *Psychology*, Holt, 1940.

QUICK REFERENCE TABLE TO STANDARD TEXTBOOKS

ALL FIGURES REFER TO PAGES

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INTRODUCTION TO THE STUDY OF GENERAL PSYCHOLOGY*

Most thinkers have a faith that at bottom there is but one Science of all things, and that until all is known, no one thing can be completely known. Such a science, if realized, would be Philosophy. Meanwhile it is far from being realized; and instead of it, we have a lot of beginnings of knowledge made in different places, and kept separate from each other merely for practical convenience's sake, until with later growth they may run into one body of Truth . . . . Psychology as a natural science deals with things in the same partial and provisional way . . . .

—William James
American Pioneer in Psychology

A science is a unit of facts or knowledge of observable existences. The facts of relationships between living organisms and their environment constitute the science of Psychology.

I. THE HISTORICAL BACKGROUND OF PSYCHOLOGY

Psychology has both a traditional and a scientific history, as has any other science. As an experimental science it dates only from about 1875—sixty years ago—although psychological experiments were performed by physicists and physiologists earlier in the nineteenth century. Traditionally, however, psychology is as old as man himself, and man philosophized about the nature of mind earlier than he did about matter.

A. Primitive Notions of Mind and Soul

Primitive peoples believed that all natural phenomena were caused and directed by certain dynamic forces. 'Hidden men' were in the lightning, thunder, rain, sun, etc. These hidden men were dynamic and active agents directing all the forces of the cosmos. Each person was

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* The following references are suggested as readings in connection with this Introduction to the Study of General Psychology.

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For an inclusive historical statement of the rise of psychology as a science read Boring: *A History of Experimental Psychology* (1929), pp. 669.

also inhabited by a hidden man, or by hidden men, causing and directing the actions of the individual in whom he resided. These dynamic forces came to be called *mind* or *soul*.

The theory that some form of mind directs the actions of the individual (and his environment) has been called *animism*. This view of mind is held by most modern primitive races, and it is the explanation used by civilized man to account for those actions of which the cause is obscure. Such a directing force (mind) cannot be studied experimentally until it has been isolated and shown to exist. Until it is described and measured it is only a pseudo-scientific conception.

B. Early Greek Theories

Primitive man was not concerned with attempts to study the cosmos. But with the coming of civilization, which brought with it leisure time and greater specialization of individual activities, certain curious men began to analyze the cosmos into elements. Among them were Thales (585 B.C.), who thought the cosmos was made of water, and Heraclitus (500 B.C.), who said the essential element was an "abstract change." Any theory explaining the cosmos in terms of one element is called *monism*.

Others attempted to analyze the cosmos into several elements. Empedocles (450 B.C.), for example, posited earth, air, fire, and water as the elements. Such a theory is called *pluralism*.

As new knowledge developed, theories of the cosmos became more objective in explanation. By the time of Plato the *mind-body problem* had arisen. Plato brought this controversy to a head by definitely recognizing two classes of phenomena: "things" and "ideas" (387 B.C.). Ideas came from two sources: some were innate and came with the soul; others were the products of observations through the sense organs. Thus we have a clear statement in these early times of the theory of *psycho-physical dualism*.

Aristotle (335 B.C.) followed the teachings of Plato and added a great deal of knowledge concerning the physiology and anatomy of the body. He made the body a more important factor in the analysis of the behavior of man. In many respects, his greatest contribution to the history of psychology was in placing emphasis on the sense organs as sources of knowledge and ideas. He described three types of soul: the plant soul, the animal soul, and the rational soul. He explained that the recurrence of ideas was due to association. That is to say, the reappearance of one factor of a situation serves to recall ideas originally connected with the situation. The associations were made by contiguity, similarity, and contrast. This later became the *doctrine of associationism* in psychology. Finally, Aristotle stressed the empirical method of observation, the basis of all scientific methods.

C. Developments During the Christian Era

During the next few hundred years the emphasis shifted from the empirical study of the cosmos to a discussion of ethics. Zeno, The Stoic, pronounced the doctrine of the eternal human soul (308 B.C.). At the same time Epicurus (306 B.C.) advanced the doctrine of 'free-will,' and denied the idea of immortality. These were followed, after the birth of Christ, by a shift from ethics to religious and spiritual doctrines. While the ideas propounded by the early Christian thinkers influenced trends in philosophy, they added but little to the study of man's behavior from the psychological point of view. St. Paul did classify subjective experience as dependent on soul, mind, and body (67 A.D.). This classification has existed to the present, especially in the field of theology. St. Augustine described conscious activity and stated his belief in its unifying and continuous development (396 A.D.). He also introduced and made use of the *method of introspection* in the observation of conscious activity.

From this time on practically nothing of interest psychologically occurred until the doctrines of *realism*, *nominalism*, and *conceptualism* were introduced during the eleventh and twelfth centuries. By the middle of the thirteenth century a renewed interest in science and philosophy became apparent. A reaction to the doctrines of The Church was also appearing. An attempt to harmonize science and religion was made by Aquinas (1257), when he differentiated between religious and scientific truth. According to him, scientific truth was based upon observation and experimentation whereas religious truth was based upon the Divine Authority of the Church. During this entire period, from the first to the sixteenth century A.D., the chief interests in the discussion of mind and soul were from the religious and spiritual angle. The next notable advances occurred with the revival of science and the philosophical publications of Descartes.

D. The Revival of Science

The scientific awakening began about 1500 A.D., along with numerous geographical discoveries. By 1600, many notable scientific investigations were well under way. Among the more important ones were those of Copernicus (1543) in astronomy, Kepler (1609) in astronomy and vision, Galileo (1609) in optics and astronomy, Newton (1672) in physics and in the psychology of vision, and Harvey (1628) in physiology. Perhaps the chief contribution to psychology by these scientists was their emphasis upon the objective study of facts in general. The study of the human mind was still largely a philosophical problem.

E. Developments in Philosophy

Descartes and his followers revived the dualism of Plato and considered the mind, or soul, as a spiritual entity, while the body was

treated as a machine (1650). Descartes is the forerunner of a modern dualism in psychology. Spinoza (1665) considered mind and body as but different aspects of the same substance. Modern exponents of this view call it the *double aspect theory.*

A reaction to the contemporary emphasis on dualism is found in the writings of Thomas Hobbes (1651). He held to the theory that man was a machine possessing nothing not found in any other machine. He revived and extended monistic doctrines and may be thought of as the forerunner of monism in modern psychology.

In England, where conscious activity had become the problem of interest, a return was made to the associationism of Aristotle. This line of thought lasted well into the 19th century. Locke had early (1690) stated that there were no innate ideas. Mind was a complete blank at birth and all ideas were obtained through the sense organs. The environment, not God, gave rise to all ideas. Berkeley (1710), on the other hand, thought that all ideas came from God and the external world existed only as a mental state. Hume (1739) carried the logic of Locke and Berkeley further and denied the existence of both God and the external world as the source of ideas. Nothing was real in life but sensitivity (sensations and ideas). Ideas were recalled through associations by similarity, contiguity, and by cause and effect.

Following these mind-philosophers came a long list of philosopher-psychologists, all of whom advocated some form of associationism as the real explanation of mental activity. Included in this group are Hartley (1749), James Mill (1829), John Mill (1843), Spencer (1855), and Bain (1859). Hartley described the physiological correlates of association as vibrations in the myelin sheaths of nerves. Association theory occupied a paramount place in English psychology until after the advent of Darwin (1859) and the subsequent interest in anthropometrics and individual differences (Galton, 1869), and statistics (Pearson, Spearman).

While these developments were taking place in England the doctrine of *mental faculties* was introduced in Germany by Wolff (1734) and extended and completed by Kant (1781). The doctrine of mental faculties classified mind into departments, such as the *intellect*, the *emotions*, and the *will*, and considered that mental activity resulted from a *faculty*, or group of faculties, which functioned independently of the rest. Gall (1809) assembled and reclassified the faculties (twenty-seven in number) and related each to a definite cranial area. His theory, known as 'phrenology,' is unsupported by modern scientific knowledge, but it is practised today by fortune tellers and pseudo-vocational advisers.

II. THE RISE OF EXPERIMENTAL PSYCHOLOGY

During the latter part of the 18th and the early 19th centuries, many notable discoveries were made in the fields of physiology, neurology, physics, mathematics, etc., which had a considerable effect on the development of experimental psychology. Haller (1759), Whytt (1750), Galvani (1792), Bell (1811), and Magendie (1822) made important discoveries concerned with functions of the nervous system and muscles, and Flourens (1824), Broca (1861), and Fritsch and Hitzig (1870) investigated the functions of certain portions of the brain. Bessel (1823), an astronomer, had become interested in individual differences in speed of reaction and had evolved the concept of the *personal equation*. The stage was being set for an experimental science of psychology but much ground-breaking had yet to be performed. Philosophical speculations concerning the nature of mind, investigations into the nature of the nervous system and interest in differences among individuals were contributing to this development.

A. Experimental Psychology in Germany

Early psychological experiments were carried on by E. H. Weber about 1830. Among other things, Weber studied the correlation between stimulation and the resulting sensitivity (sensation). He was followed closely by J. Müller (1834), who worked on visual space perception and developed the theory of the 'specific energy of the nerves' as related to the different sensitivities. Fechner (1860) gave us the *psycho-physical methods* for the observation of conscious activity. He extended Weber's work, modified his conclusions, and reformulated on a mathematical basis the Weber law of the relation of stimulation and sensitivity. Helmholtz (1863) developed theories of color vision and audition, based upon experimental work, and Hering (1878) also formulated a theory of color vision as the result of work in this field. The color vision theories of Helmholtz and Hering and the theory of audition of Helmholtz are standard theories today. Helmholtz's investigations are equally important in physics, physiology, and psychology, and most of the experimental work of this period was of a border line nature as far as psychology is concerned. Psychology was only emerging as an experimental science during the latter half of the nineteenth century.

Experimental psychology may be said to date from the first officially recognized laboratory of psychology, which was founded at Leipzig, Germany, in 1879 by Wilhelm Wundt. Wundt is credited with the first strictly laboratory experiment in psychology in 1849. His chief experimental interest was in conscious activity and in determining the *structure of the mind*, although he wrote much of a speculative nature, as in his *Folk Psychology*. Psychologists from many countries, and especially from the United States, went to study with Wundt who was the recognized leader of the new science of psychology.

B. Psychology in England and France

The emphasis since the latter part of the 19th century in France has been upon abnormal psychology and mental tests. Ribot, in explaining memory and the relationship of somatic conditions to mind, introduced material from the abnormal field (1885), and Binet and his colleagues, devised the first intelligence test in 1905.

Early developments in England have already been mentioned as concerned with the conscious association of ideas, which was purely mental philosophy. Laboratory psychology was slow in taking root in England. But under the biological influence of Darwin, the productive field of individual differences was explored by Galton (1869) and led to the development of statistical methods in which England took world leadership with such men as Pearson and Spearman.

C. Psychology in America

Three lines of influence are manifested in the activities of American psychologists, namely: the experimental laboratory emphasis of Wundt (1879), the Darwinian theory of evolution (1859), and the mathematical concept of the normal probability curve (Gauss, 1809). All are reflected in the laboratory experiments, the genetic studies, and the statistical techniques of American psychology.

D. American Pioneers

James (1842-1910) probably influenced the thinking of his contemporaries and successors more than any other single American psychologist. His early training had been in physiology, but by 1875 he was teaching psychology and demonstrating his lectures with experiments. He studied memory and the transfer of training experimentally, devised what has been the most stimulating theory of emotions, and by his textbook, *Principles of Psychology* (1890), influenced American psychology and education for many years.

G. Stanley Hall, (1844-1924), pioneer Genetic Psychologist, exerted a tremendous influence upon psychological theory in American education. He introduced the child study movement into America and wrote extensively on child psychology, adolescence, and senescence. Hall founded the first psychological laboratory in this country at Johns Hopkins (1883) but soon went to Clark University as its president (1889). He founded the first psychological journal in America, *The American Journal of Psychology* (1887), and was the first president of the American Psychological Association (founded in 1892).

Among other pioneers who exerted their influence along special lines, are Ladd (1842-1921), who worked in the field of physiological psychology, and Catell (1860-), who supplied the impetus to the mental testing movement and the study of differential psychology in America.

E. Ten Historical Landmarks

A short list of landmarks, in the development of psychology as an experimental science, follows.

1860 Introduction of psycho-physics with publication of Fechner's *Elemente* in Germany.

1873 Introduction of Experimental Psychology with publication of Wundt's *Physiologische Psychologie* in Germany.

1877 Development of correlation method by Galton in England.

1879 Founding of first laboratory of psychology by Wundt in Germany.

1881 Founding of first journal of Psychology (*Philosophische Studien* and later *Psychologische Studien*) by Wundt in Germany.

1883 Introduction of psychometrics with publication of Galton's "Inquiry Into Human Faculty" in England.

1885 Development of Sigma Measurement (1000th of a second or a millisecond) by Cattell in America.

1887 Founding of the first American journal (The American Journal of Psychology) by G. Stanley Hall.

1890 Establishment of Dynamic or Functional Psychology with publication of James's "Principles" in America.

1892 Founding of first association of psychologists (The American Psychological Association) with G. Stanley Hall as President.

III. PSYCHOLOGY AND COMMON-SENSE (PRACTICAL PSYCHOLOGY).

Science and common-sense deal with the same material, but common-sense conclusions are frequently erroneous because of the confused relation between cause and effect. An anthropologist tells a story of a very queer custom of an Eskimo tribe in which the wrong cause is related to a desired effect. Fishermen of the tribe, before entering the boats to go fishing, must throw a ham-bone over their left shoulder. This custom originated during a famine. The men had been fishing daily without success. One day a fisherman picked up a ham-bone to throw it out of his way before stepping into his boat. He happened to cast it over his left shoulder and because that day's efforts netted a very large catch of fish, the wise men of the tribe interpreted this behavior to be a necessary prelude to fishing. We see in this custom an erroneous common-sense connection between cause and effect. It illustrates the development of many traditions, opinions, and ways of doing things in various societies.

Everyone is a *common-sense psychologist* just as he is a common-sense physicist, chemist, or biologist. We make judgments concerning the behavior of people before we study psychology as a science, just as we did of physical objects before we studied physics or chemistry. But because our daily life is so closely related to the behavior of other people, we are less inclined in the psychological field to recognize the distinction

between scientific observations and those which are made in the haphazard fashion of daily intercourse. We accept common-sense opinions without question when they concern other people. We would question such opinions immediately if they were made in the field of mechanics. The field of psychology is peculiarly susceptible to looseness of opinion.

It must always be kept in mind that common-sense psychology is based upon *casual observations,* which may or may not be accurate. It teaches us, through experience and through reflection upon the way others act in certain situations, how people are likely to act in the future. However, it is still a common-sense psychology and its conclusions are often inaccurate. The chief distinction between common-sense psychology and scientific psychology lies in the method of arriving at generalizations. The scientific method increases the reliability of observation.

IV. SCIENTIFIC PRINCIPLES

Six general scientific principles, with which the reader may already be familiar, are the basis for psychological investigation and experimentation.

A. Scientific Method

Psychology, like all other sciences, employs the method of observation. Observation under highly controlled technique is called an experiment. The experiment is observation in its most scientific stage. In any psychological investigation numerous observations are made. Take, for example, the study of the curve of learning. Observations are made upon the progress in learning of a great many individuals which when averaged or classified are shown as a learning curve typifying learning in general. The learning curve is the law, or generalization, of progress in learning and it may be verified over and over with many kinds of learning, e.g., foreign languages, mathematics, acts of skill, and so on.

A scientific investigation involves:

(1) *observation*—the collection of a large body of facts,

(2) *classification*—the grouping and averaging of these facts,

(3) *verification*—duplicating the conditions of the investigation until there is no doubt of the uniformity of results, and

(4) *generalization*—the formulating into law of this uniformity.

Persistent training in observation is necessary for accuracy; persistent training in controlling outside influences is always necessary to obtain an exact measure of the phenomenon being studied. This is what is meant by laboratory training. The investigator should be trained

in observing the particular item under study. He should arrange carefully the setting of the material, eliminate outside influences, and then describe these conditions so that the experiment can be repeated by others for verification.

Provisions to secure unprejudiced observations are an important feature of the scientific method. Since observers, despite diligent training, are rarely absolutely accurate and sometimes misled by expectation or desire, the scientific method makes provision for repetition of observations. But even under the most carefully controlled conditions, the finest observers frequently secure results that are incomplete and erroneous. Much ingenuity has, therefore, been employed in the search for mechanical devices designed to supplement or supplant ordinary observation. Advances in psychology, as in other sciences, have resulted from the invention of instruments that have made observations more detailed, accurate, and intensive. Whenever possible the investigator should supplement his observations by the use of such mechanical devices, especially those which yield a permanent record of facts. He should present the observed data in quantitative terms as far as possible and these data should be analyzed by statistical methods in order that their reliability may be ascertained.

8. Scientific Viewpoint

The scientific point of view of doubting everything is maintained in psychology. There is always the temptation to guess or imagine the results that seem most likely.

Everyone has an opinion about almost every subject. These opinions are just as likely to be wrong as right. Superstitions and group opinions are passed down from generation to generation.

The origin of opinions and of the ways of doing things is most admirably discussed by Wm. Graham Sumner in his book, *Folkways*. These folkways are really group habits or common responses to like situations, e.g., ways of plowing or tilling the soil, ways of dressing, ways of building houses, treatment of children, drunkenness, methods of religious worship, etc. Some of these ways are considered necessary for social welfare. They are described by Sumner as the group *mores*, or the ways of doing things for which society will punish the transgressor. In the story of Eskimo life we have an illustration of the development of *mores*.

The scientific psychologist is the doubter and the tester of all opinions relating to mental activity. He is a doubter of all conclusions gained by the *common-sense method*—and by the scientific method if they have not been verified. So with the physiologist for physiological opinion; so with the physicist for opinions upon physical phenomena. The scientist is always a doubter.

C. Only Observable Phenomena Investigated

The psychologist believes, along with other scientists, that only such matters, or phenomena, as can actually be observed to exist can be investigated. This workable scientific theory takes for granted the reality of time and space and the quality and quantity of matter, or phenomena, as they exist in space and time.

Psychology does not include mystical forces, spiritual entities, unknown powers, and the like. Scientific psychology is concerned with mental life in so far as it is observable, just as physics or chemistry are concerned with matter that is observable.

D. Psychological Events Have a Cause

This statement may be made for all sciences. It is called universal determinism. The laws of psychology, and of all the sciences, are the proof of it. Each event has a cause and this event in turn was caused, and so on.

This causal sequence exists in mental activity. Every thought has a cause. Every act has a cause. There are no isolated situations in mental life. This is simply saying that mental activity obeys natural law.

Recognition of the causal sequence of mental situations is nothing new. Aristotle and Plato took this view. Freedom of action in the sense of causelessness is an empty concept. Many notions of the freedom of action, or the freedom of the will, are of the kind spoken of by Hobbes: "A top, which is spun by a boy," says Hobbes, "and runs about, first towards one wall then towards another, would think, if it perceived its own motion, that it moved about by the exercise of its own will, unless it happened to know what was spinning it."

Uncaused action is a notion of the unthinking man. Some believe in a causal sequence with an intervening supernatural power. There are as many varieties of beliefs in uncaused action as there are pickles. All are unscientific. Mental phenomena follow the law of causal sequence. In order to understand the thoughts and actions of man we must treat them as we treat the movements of physical bodies. Every event has a cause.

E. Psychology is not Concerned with Ethical Values

Lack of concern with ethical values is characteristic of all sciences. Science has no relation to moral issues. Psychology investigates mental activity without praise or blame—without evaluating the activity. There is no good or bad, no useful or useless, no vulgar or refined, no right or wrong, no moral or immoral, in science. The scientist is a seeker after facts, after the natural sequence of cause and effect. To raise a moral issue about these facts is not within the province of the scientist. Of course, the knowledge uncovered by the scientist may be of tremendous social importance, but to the scientist it remains just facts.

F. Psychology Accepts Hypotheses or Theories

While science aims at generalization into laws from the classification of observations, before this is possible it often accepts a hypothesis or theory that explains most of the known facts, or one which has the widest application. This is used as the point of attack for future investigation.

However, it favors the simplest explanation. This is the *Law of Parsimony,* which is stated best in psychological terms in what is known as Lloyd Morgan's Canon (1899): "In no case may we interpret an action as the outcome of the exercise of a high psychical faculty (mental activity) if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale."

V. A PRELIMINARY DEFINITION OF PSYCHOLOGY

Psychology has been called "the study of the mind," and while this is not doubted, the definition leads one into a philosophical discussion of the nature of and existence of mind. Such a discussion is fruitless, for we cannot know what mind is until we assemble all of the facts about it, and this is the purpose of psychological investigations. We want a working definition of psychology. One was proposed as follows: "Psychology is the study of human nature." We seem to understand this because it is practical and appeals to our common-sense. But 'human nature' is a term fully as vague as mind. We have the same difficulty in agreeing upon what is human nature as we did upon what is mind.

The only definition of psychology which seems entirely satisfactory (and it would also define any other science) might be stated as follows: "Psychology is the assembled verifiable facts of investigations from the psychological point of view." So we see that it is the psychological point of view which should be defined. Following is a preliminary definition of point of view in psychology. *The science of psychology studies the mass activities of living organisms.* It is concerned with coordinated activities of animals and human beings, which are studied as a whole or as a unit. Psychologists are interested in these activities as they are expressed both in consciousness and in behavior.

VI. THE DEVELOPMENT OF OBJECTIVE TESTS

In 1885, Ebbinghaus in Germany devised the first completion test in a study of memory. He gave sentences with one word missing and a blank left to indicate where the word belonged. The subject was required to recall the proper word and write it in the blank space. Ebbinghaus' work has formed the basis for the development of this important form of measuring the ability to recall.

Recognition is another form of memory expression. Recognition tests were devised and used as early as 1914. In these tests, a statement is presented and the subject is asked to recognize it as being either right or wrong. In another form of the recognition test the statement is given with several answers, one or more of which is correct.

Recall and recognition are both expressions of knowledge. Tests of recall and recognition tell how much one knows in the study of psychology* or any other subject.

These test techniques have several advantages: (1) a wider range of subject-matter can be included than in the essay examination because the student has little to write to indicate his selection of an answer. (2) The papers can be marked by the use of a stencil, or prepared answer key, and require only a short time for correction. (3) The scores obtained are less influenced by opinion; regardless of who marks the papers the scores will be the same since the marking is done by stencil.

A. The True-False Test

One of the tests for recognition of previously encountered facts is the 'true-false,' or 'plus-minus,' or 'right-wrong,' test. In this test a statement is given and the student is required to indicate whether the statement is true or false. In such tests, if a statement is partly true and partly false the student is directed to judge it as false. An item must be entirely true to be considered true. Following are some true-false statements covering the preceding discussion. Indicate your answer by placing a T before each true statement and an F before each false statement. The first item is answered correctly.

F 1. Locke denied the existence of God and the external world
2. The theory of psycho-physical dualism maintains that only sensations and ideas are real.
3. Aristotle explained the occurrence of ideas as being due to association.
4. Descartes and his followers revived the dualism of Aristotle.
5. William James was an exponent of the genetic study of psychological activity.
6. Wilhelm Wundt was interested in determining the structure of the mind.
7. Cattell worked chiefly in the field of physiological psychology.
8. The development of modern scientific psychology dates from 1859.
9. A conception which cannot be isolated and shown to exist cannot be studied experimentally.
10. Every event may or may not have a cause depending upon whether it is a physical or a mental event.

* In Appendix I are six tests on the chapters to follow in this book. The book is divided into three parts and there are two tests for each part. After completing the study of Part A, take Tests I and II; after Part B, take Tests III and IV; after Part C, take Tests V and VI.

B. The Multiple-Choice Test

Another test of recognition is the multiple-choice or multiple-response test. In this test a statement is made and the student is required to answer by selecting the correct one, or more, of several given answers. Below are some multiple choice items based on the preceding discussion. Indicate the correct answers by printing the letter or letters on the line before each item. The first item is answered correctly.

D 1. The correlation method was first developed by (A) G. Stanley Hall, (B) Ladd. (C) Binet, (D) Galton, (E) Müller.

2. The activities of American psychologists have been influenced by (A) the mathematical concept of the normal probability curve, (B) Wundt's *Folk Psychology*, (C) the Darwinian theory of evolution, (D) the experimental laboratory emphasis of Wundt, (E) Ribot's explanation of memory and the relationships of somatic conditions to mind, (F) the concept of a personal equation.

3. A view of mind as a directing force has been held by (A) Hobbes, (B) modern primitive races, (C) Galen, (D) British empiricists.

4. (A) Anaximander, (B) Anaximines, (C) Pythagoras, (D) Thales, (E) Empedocles thought the cosmos was made of water.

5. The doctrine of the eternal human soul was introduced by (A) Galen, (B) Epictetus, (C) Epicurus, (D) Zeno, (E) Democritus.

6. The theory of mental faculties was formulated by (A) John Mill, (B) James Mill, (C) Bain, (D) Wolff.

7. By universal determinism is meant: (A) In no case may we interpret an action as the outcome of a high psychical faculty if it can be interpreted as the outcome of one lower in the psychological scale, (B) Every effect has a cause, (C) Every law of nature is simply a description of a high correlation, (D) Every event is intelligible only as a direct effect of an active universal soul.

C. The Matching Test

The matching test is a more difficult form of the multiple-choice test. Two sets of items are given and the student is required to indicate the items which belong together. In the following test the two items should be matched. Print on the line at the left of each number the letter beside the answer at the right which goes with the statement at the left. The first item is answered correctly.

C 1. Introduced the use of the introspective method.

2. First stated the doctrine of 'free-will.'

3. Advocated two kinds of truth: religious truth and scientific truth.

4. Was a noted English associationist.

5. Formulated the 'recapitulation theory' in psychology.

6. Name of the theory that some form of mind directs events in the cosmos.

7. Invented the correlation method.

8. Founded the first psychological laboratory.

Answers

A. Galton
B. Hartley
C. St. Augustine
D. Aquinas
E. Hall
F. Animism
G. Epicurus
H. Wundt

D. The Completion Test

The completion test is a test of recall. A statement is given with a word, or phrase, missing. The student is required to supply the missing word, or words, to make a complete and true statement. In the completion test below, which is based on the preceding discussion, the number of words necessary to complete each statement, and make it true, is indicated by the figure in the parentheses. Write the required words on the appropriate line at the right of each statement. The first statement is answered correctly.

1. For Aristotle, associations were made by (1), (1), and (1). — Contiguity; Similarity; Contrast

2. Fechner developed the (1) methods and attempted to formulate the laws of (1) on a (1) basis.

3. French psychology during the latter part of the nineteenth century placed particular emphasis on (2) and (2).

4. That mind and body are but different aspects of the same substance was first advocated by (1) This view is now known as the (2) theory.

5. The method of introspection was introduced by (1).

6. The doctrine of mental faculties classified mind into such departments as (1), (1), and (1).

7. The theory of 'phrenology' was introduced by (1)

8. Plato recognized two classes of elements· (1) and (1).

9 Aristotle described three kinds of soul: the (1) soul, the (1) soul, and the (1) soul

10. A scientific investigation involves four steps: (1), ... (1), (1), and (1).

VII. REFERENCE WORK IN PSYCHOLOGY

No person can come to grips with the facts and principles of a science through one reading of a general textbook upon the subject. It is desirable to read widely even though he reviews much that he has read before. There are numerous excellent textbooks in general psychology which are written to summarize the facts and principles of the science. Texts having the word 'experimental' in the title emphasize the methods used in the collection of scientific data. Some books present a particular theoretical point of view.

After general familiarity with the science has been attained it is not desirable to read only textbooks. Books in specialized fields, such as physiological psychology, intelligence measurement, mental abnormality, and the like, offer more intensive reading in facts and principles. They are for the reader who desires to search deeper in a special field.

Reports of research (articles and monographs), which are in scientific journals, are the sources used in the assembling of facts and principles of psychology. General books are written from these original sources. A student of psychology should be familiar with such journals as the *American Journal of Psychology* (founded in 1887), the *British Journal of Psychology* (founded in 1904) and the *Psychological Abstracts*, which abstracts all journal literature in Psychology.

A. Chapter References

Preceding each chapter in the text which follows are references to books discussing the topics of the chapter. The list, while not inclusive of all books with material upon these topics, is representative of recent textbooks and includes references to older or specialized books where there are discussions of important facts and theories which will be of interest to the reader. No references to journals are included. Such references may be found in the *Psychological Abstracts*. Textbooks differ as to their content, organization, and theoretical viewpoint. For this reason a student should review several textbook references even though they overlap and duplicate each other.

Some of the references, introducing each chapter in the text, are in bold-face type. These are 'Preferred Readings,' which are selected because they cover a wide variety of the material upon the topics of the chapter, offer contrasting points of view, and are most accessible to the reader.

B. A Bibliography of General Psychology

The bibliography of books in General Psychology, which follows this introduction, includes works representing the science as a whole and important fields of the science. All books which are listed in the chapter references are included in the bibliography.

A student of psychology will wish to own some of these books for personal reference and study. He will not wish all of them to be text-books in which is included essentially the same material. In the bibliography, ten of the references are in bold-faced type. These books are thought of as an up-to-date 'Ten-book-shelf in General Psychology.' They form a small reference library introducing the student to general psychology.

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Part A

THE ELEMENTS OF PSYCHOLOGICAL ACTIVITY

We can never determine man's fitting
estate until we know his true nature.

—G. Stanley Hall
Pioneer in Genetic Psychology

Part A is a study of the physical, chemical, physiological, conscious, and behavior factors which function in relation to each other in psychological activity. They constitute the elements of psychological activity.

The following chapters are included in Part A:

Chapter I. Stimulation, Integration, and Reaction
Chapter II. Sensitivity: Awareness of Stimulation
Chapter III. Reaction: The Study of Behavior
Chapter IV. Psychological Dynamics

The first chapter outlines the study of psychological activity as concerned with the stimulation of receptors, integration within the organism, and the reaction as the resultant of stimulation and integration. Chapter II discusses the awareness of environmental stimulation, which is a study of conscious integration. Integration is observed in the nervous system, in the chemical activity of the bodily organs, and in awareness. The elemental reaction forms are discussed in Chapter III. The final chapter upon psychological dynamics is a study of the causes of psychological activity.

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CHAPTER I

STIMULATION, INTEGRATION, AND REACTION

Scientific psychology is the study of stimulation (S), integration (I), and reaction (R). It studies psychological activity (S-I-R) as it appears in its various manifestations in all forms of life.

I. THE S-I-R FORMULA (A PRELIMINARY DISCUSSION)

Human beings and animals, which are referred to in psychology as 'the organism,' are reacting mechanisms. The stimulus is the causative factor. Integration, or coordination, of the reaction is provided by the organism. The reaction of the organism is an event resulting from

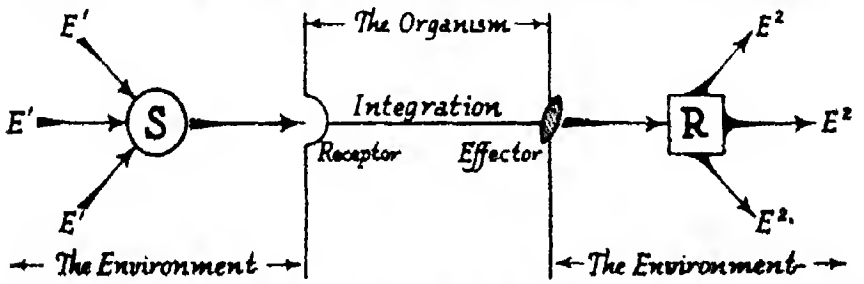

Fig. 1. Action of environmental energy changes (E^1) upon the organism through receptors is called the stimulus (S). Action of the organism in producing environmental changes (E^2) through effectors is called the reaction (R). The organism's contributions to the total activity is called integration (I). The environmental changes (E^2) may in turn become stimuli which act upon other receptors in the same organism or in different organisms.

stimulation and integration. These three related factors: (a) stimulation, (b) integration, and (c) reaction, make up the *S-I-R formula* of psychological activity. S-I-R activity may be regarded as a preliminary definition of the field of the science.

A. The Stimulus

A *stimulus* of environmental origin consists of physical or chemical changes which are capable of producing a physiological change in receptor organs. These environmental changes may be external or internal, as related to the body, and they affect both external and internal receptors, such as the retina of the eye, the organs of equilibrium in the internal ear, and the taste bulbs of the tongue. There are environmental changes for which there are no receptors and changes outside the range of receptivity, such as X-rays, infra-red waves, ultra-violet waves, and auditory vibrations above 20,000 d.v. per second.

A unit of environmental stimulation often is called the *environmental stimulus*. It is a mass of such environmental changes capable of affecting receptors at any one time. It is a *total situation* in its mass effect. But in experimental investigations in psychology, stimulus often refers to one specific factor in the total situation which is being measured, such as the intensity of a tone or the duration of pressure.

B. Integration

Integration is *central activity*. It is action between *receptor* and *effector*. The organism's contribution to the reaction is termed integration. There are two important aspects of integration: (1) the physiological and (2) the awareness or conscious. Both these aspects of integration are highly complex and involve the study of nerve physiology and the development of thinking in awareness. In a consideration of causes, this central activity often is referred to as central or integrative stimulation and the unit of stimulation at any one time as the *integrative stimulus*, which is a part of the total stimulating situation.

C. The Psychological Reaction

The *psychological reaction* is the resultant of reception of stimulation and integration within the organism. The psychological reaction is the action of the organism upon the environment by means of effectors, such as muscles and glands. An understanding of reaction involves a study of effectors.

II. THE PSYCHOLOGICAL ENVIRONMENT

The *environment* of the psychologist is the same as the environment of the physicist, with a change in point of view from that of description and measurement of physical objects and their activities to that of description and measurement of the effect of these physical objects and activities upon an organism. The physical objects and activities which affect an organism are termed the *psychological environment* and any unit of this environment, the stimulus. The psychological environment is divided into (a) an explicit environment and (b) an implicit environment.

A. Explicit Environment.

'Explicit' refers to action external to the body, and the organism's explicit environment is made up of physical objects and activities which stimulate the body from without.

B. Implicit Environment

'Implicit' refers to action within the body and the organism's implicit environment is formed of organs, muscles, objects, and activities within the cavities of the body which stimulate the body from within.

III. A BIOLOGICAL CONSIDERATION OF THE ORGANISM

The organism is formed of protoplasm. Protoplasm is living substance. It makes or forms all bodily structures.

A. Specific Functions of Protoplasm

Besides the various vegetative functions of protoplasm, the following specific functions are essential to psychological activity: (1) irritability, (2) contractility, (3) conductivity, (4) plasticity. These biological functions are studied on the psychological level as: (1) receptivity or sensitivity, (2) reaction, (3) integration, (4) development or learning.

B. The Cell Theory

Cells are living units of protoplasm. They are anatomical, metabolic, and often reproductive units. The organs and units of activity of the body are formed by cells.

C. Specialized Function of Cells

Cells are frequently specialized for the better performance of one function. This is accompanied by a low degree of specialization of other functions. Particularly in the higher forms of living organisms, cells are specialized to a high degree for sensitivity, integration, and reaction.

IV. SENSITIVITY (RECEPTIVITY)

Protoplasm in all its forms is sensitive to mechanical and chemical stimulation. But the reception of stimulation is frequently accomplished by means of cells specialized in some one form of sensitivity. These cells are organized into receptor organs. Receptors perform the psychological activity of receiving stimulation. A receptor is an organ composed of specialized protoplasm highly sensitive to some particular complex of environmental changes and relatively insensitive to others.

A. Structural Organization of Receptors

There are usually two parts to a receptor:

1. Sensitive Cells. These are cells which are specialized for the reception of a particular kind of stimulation.

2. Accessory Apparatus. The accessory apparatus is formed of cells organized into structures which focus the stimuli upon the sensitive cells.

B. Classification of Receptors

Receptors may be classified into the following groups according to their explicit or implicit location in the body. The classification is after Sherrington.

1. Exteroceptors. Exteroceptors are located in the outer surfaces of the body and are stimulated by energy changes external to the organism.

2. PROPRIOCEPTORS. Proprioceptors are located in the linings of the muscles, tendons, and joints and are stimulated by energy changes resulting from the movement of these structures.

3. INTEROCEPTORS. Interoceptors are located in the linings of the viscera, the digestive, respiratory, and circulatory systems. They are stimulated by energy changes affecting these parts.

According to their action in relation to environmental stimulation, exteroceptors are explicit receptors and proprio- and interoceptors are implicit receptors.

C. Degree of Sensitivity

There are differences in sensitivity among various organisms due to different kinds of receptors and to different development of the same receptors.

D. Range of Human Sensitivity

Compared to the range of environmental changes of any one sort, the range of sensitivity of receptors is limited.

V. REACTION (RESPONSE)

Protoplasm in all its forms has the property of reaction. But the reaction of the higher organisms, to which the study of pyschology is largely confined, is the resultant of the activity of a unit of specialized contractile cells, called an effector.

A. Effectors (Organs of Reaction)

Effectors are reaction units formed of muscle fibres or glandular tissues. They may be muscles, or groups of muscles, or glands. The effectors are responsible for the action of the organism upon its environment.

B. Stimulation (Innervation) of Effectors

Muscle fibers are insulated from each other by a membrane and are stimulated individually by *efferent* nerve fibers. One nerve fiber spreads its *fibrils* over several muscle fibers. This structure is called the *motor end-plate*. The unit of stimulation, including the motor end-plate and the muscle fibers stimulated by it, is called the *neuro-muscular unit*. Many neuro-muscular units function together in the action of an effector.

C. Classification of Effectors

Effectors are classified upon both structure and function. The two main classes are muscles and glands.

1. Muscles. On the basis of structure, the muscles are subdivided into two groups: striped (striated) muscles and smooth (unstriated) muscles. Functional differences are related to the differences in structure.

a. *Striped (Striated) Muscles.* The striped muscles are so named because of their striped appearance. Each muscle is made of several hundred tiny thread-like fibres each of which is enclosed in a sarcolemma sheath and is innervated separately. The striped muscles move the bones of the skeleton and are responsible for bodily movements. They are located peripherally in the organism and they are so placed that their action is upon the explicit environment. Striped muscle reactions are initiated and terminated more quickly than smooth muscle reactions. Striped muscles are called also somatic effectors.

b. *Smooth (Unstriated) Muscles.* The smooth muscle effectors are muscular membranes situated throughout the *viscera* and in a few other organs such as the iris of the eye. They function in the pulmonary, circulatory, and metabolic activities of the organism and their action is upon the implicit environment. They function more slowly than striped muscles and their action is said to be involuntary, i.e., they are relatively uninfluenced in the conscious activities of the organism.

2. Glands. Glands are aggregates of cells specialized for the secretion of certain chemical substances. On the basis of structure they are classified as duct glands and endocrine (ductless) glands.

a. *Duct Glands.* Duct glands secrete their products through small ducts opening into some cavity or onto the surface of the skin. The tear glands and the salivary glands are duct glands.

b. *Endocrine Glands.* The endocrine glands have no ducts but secrete their products directly into the blood stream or lymphatic system. Lately much importance is attributed to the effects of endocrine secretions upon behavior. The more important endocrines are the adrenal, thyroid, thymus, parathyroid, pituitary, pineal, and part of the sex glands. The secretions of the endocrines are called *hormones* or *autocoids.*

D. Explicit and Implicit Effectors

Explicit effectors are the somatic striped effectors acting upon the environment surrounding the body. There are a few others. The sweat glands, which are duct glands, are explicit effectors. The implicit effectors are the smooth muscle effectors, and the duct and ductless gland effectors which act upon the environment within the body.

E. Pattern Reaction (The Behavior Unit of Psychological Activity).

The action of many effectors is organized or integrated into a pattern reaction, which is the behavior unit of psychological activity. Any reaction involves all of the effectors of the body in various degrees, but the essential part of the reaction is the pattern of a few effectors.

For example, in throwing the arm over the head, effectors are extended and contracted throughout the body in maintaining posture, but the reaction is defined by the contraction of the muscles of the arm.

F. Successive and Simultaneous Reaction

There are few *simultaneous pattern reactions,* where a single coordinated pattern completes the activity. Reactions are coordinated in sequential order. That is to say, one pattern leads to another, and that to another. One reaction is the successor of the one preceding it, and so on. The *successive pattern reaction* is the unit of study in most psychological investigations of behavior.

VI. INTEGRATION

Integration has been defined as central activity, between receptor and effector. However, integration is determined by structure. Common patterns of reaction depend upon like structures. Structural differences between species cause differences in reaction patterns, and differences in skeletal and muscular structures among individuals of the same species cause differences in magnitude of reaction. While the structural basis of integration is obvious, these fundamental causative facts cannot be ignored.

A. Conscious Integration

Integration is traced in awareness (consciousness). The integrative stimulus in awareness is observed as intent to act, to learn, to work, and so on. Activity in consciousness is very complex. Sensitivity is the simplest awareness of our environment. It may be visual, auditory, and so on. As we sense, or as we remember, we judge and reason in relation to a goal, which is caused by the integrative stimulus in consciousness.

B. Physiological Integration

Physiological integration is studied in the activity of the nervous system and in the chemical action of the glands.

1. Chemical Integration. Chemical action in the pulmonary, alimentary, and circulatory systems facilitates and inhibits psychological activity. Metabolism slows or speeds integration through the blood supply, which is furnished to various parts of the organism, such as the brain and the effectors. The whole physiology of the organism determines integration.

2. Nervous Integration. The structures of the nervous system are divided into (1) cerebro-spinal system and (2) sympathetic (autonomic) system. The latter controls most of the implicit action of smooth muscle and gland effectors and the former controls the explicit action of the striped muscle effectors. Stimulation of receptors affects the cerebro-spinal system, and only indirectly the sympathetic system. The neuron is the structural unit of nervous integration. Many neurons

are active in the conduction of stimulation from the receptors to the effectors. Nervous integration is evident in the drainage of energy into common paths in the nervous system for the stimulation of effectors.

VII. SUMMARY

The S-I-R formula represents psychological activity in all its manifestations: it represents life as the psychologist views it. But the psychologist is concerned with the investigation of parts of this activity. He may work a life-time upon one form of sensitivity, such as pressure, or on the electrical changes in one form of reaction. The chapters which follow summarize the facts and generalizations of these investigations which have been made upon various large units of S-I-R activity.

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CHAPTER II

SENSITIVITY

THE AWARENESS OF STIMULATION

Sensitivities are the simplest forms of awareness activities. Reports of sensitivities usually are correlated with the stimulation of receptors. These reports are referred to as *introspections.*

I. THE OBSERVATION AND CLASSIFICATION OF SENSITIVITIES

Sensitivities (also called sensations or sensory discriminations) are classified into departments or *sense modalities* according to relationships established among the receptors, the psychological stimuli, and the *qualities* of the sensitivities.

A. Special vs General Sensitivities

Certain receptors contain highly differentiated structures which are responsible for greater specialization of the sensitivities. Because of this specialization they are called the *special sensitivities.* The special sensitivities are vision (sight), audition (hearing), olfaction (smell), gustation (taste), and equilibrium. The receptors for these sensitivities are, respectively, the retinas of the eyes, the auditory labyrinths of the ears, the Schneiderian membranes of the nose, the taste bulbs of the tongue and mouth, and the non-auditory labyrinths of the ears. These receptors are organizations of sensitive tissues and accessory apparatus for the reception of specialized stimuli.

The *general sensitivities* are differentiated because of differences in the stimuli and sensitivities and not because of specialized structures in the receptors, although it is concluded by some workers that differences in receptors do exist. Numerous 'cylinders,' 'bulbs,' and 'corpuscles' have been designated as receptors for the general sensitivities but there is no authoritative evidence that there are any specialized receptors among them.

The general sensitivities are reported as pain, pressure, and temperature and they are divided into the cutaneous sensitivities, localized upon the outer surface of the body, and the kinaesthetic (sometimes called motor) and organic sensitivities, which are less definitely localized in the linings of various internal surfaces of the body.

B. Distance and Contiguous Sensitivities

Some of the receptors are stimulated by environmental changes originating at a distance from the organism. On this basis the visual, auditory, olfactory, and certain cutaneous sensitivities are called *distance sensitivities. Distance receptors* are, in general, more specialized and more complex than *contiguous receptors* (non-distance receptors), and the distance receptors represent a genetically later development of cells specialized for reception of stimulation.

C. The Description of Sensitivities

The sensitivities are introspective reports of awarenesses. Each sensitivity differs in *quality* (its name), in *protensity* (its duration), in *intensity* (its magnitude), and in *extensity* (its spatial localization and movement). These are *dimensions* (*attributes* or *variables*) of any sensitivity. *Clearness,* which is the definiteness or focus of these dimensions, is sometimes called a dimension. *P-U* (pleasantness and unpleasantness) is an affective dimension, and when reported the awareness is called an affectivity.

II. VISUAL SENSITIVITY (SIGHT)

Vision is the most complex of all the special sensitivities. It is a distance awareness. The structures of the receptor (the eye) are highly specialized for the focalization and reception of visual stimulation.

A. Stimulation

Stimulation of vision is by 'light rays,' which often are called ether vibrations. All 'light rays,' or waves, travel very rapidly at a uniform rate of about 186,000 miles per second (299,516 kilometers). It is said that these waves travel like ripples in the water and more of the short ones reach a given point in a given time than do the long ones. The length of the waves from one crest to the next, which are within the range of human sensitivity, vary from 760 mμ (millionth of a millimeter) to 390 mμ. Each color quality is caused by a definite range of wave lengths. A color quality, which is a visual sensitivity, should not be confused with wave length, which is a visual stimulus. The relation of color quality and wave lengths is shown below (after Warren, *Dictionary,* p. 316).

Color Quality	Wave Length mμ
Red	760-647
Orange	647-588
Yellow	588-550
Green	550-492
Blue	492-433
Violet	433-390

The visible range, then, is 760-390 mu. The number of vibrations per second reaching a given point for this visual range is 395 to 769 trillion. Light waves also vary in magnitude (the ripples are higher), as well as in length. Differences in the magnitude of light waves determine the intensity of the visual sensitivity. There are various exceptions to these correlates between stimuli and sensitivities.

B. Receptors

The specialized sensitive structure of vision is the *retina* of the eye, one of the inner tissues of the eye ball. Reception in the retina is said to be a chemical process. Extensive accessory apparatus, such as the lens and accommodation muscles, assist in focalizing the light waves upon the most sensitive central part of the retina (the *fovea centralis*). Light rays travel inward, through the cornea, the aqueous humor (a transparent liquid holding the outer part of the eye in place), the lens (which is accommodated to focus light from sources at different distances on the retina by the action of ciliary muscles), the vitreous humor (a transparent supporting liquid), to the retina (an inner layer of nerve cells surrounded by the choroid and sclerotic coats). The choroid is opaque and is differentiated ventrally as the iris, which is a muscle that contracts and expands under different intensities of light stimulation to form the pupillary opening. Six muscles operate to move the eye-balls in their sockets so that there is convergence of the two eyes upon environmental stimuli. The retina of the eye is formed of nerve cells and the dorsal layer (of ten layers) is formed of the sensitive cells called *rods* and *cones*. There are about 137,000,000 rods and cones in the retina of each eye (Krause) and they vary in diameter from 0.002 to 0.006 mm. The optic nerve is formed of fibers from the retina which pass in a body (dorsally) from the ventral surface of the retina. The area where they join together, where there are no rods and cones, is called the *blind spot* (on nasal side of the *fovea centralis*). Rods are sensitive only to light stimuli and they are more sensitive than cones to light stimuli of low intensities. Cones are most sensitive to both color and light stimuli of normal intensity (von Kries Duplicity Theory, 1894). The *fovea centralis* is formed only of cones and fewer cones and more rods are found as one surveys the surface outward toward the extreme periphery of the retina (where only rods are found). There is a corresponding change in color sensitivity with three areas distinguished as follows,

1. A central area in which there is sensitivity to all color, as well as light stimuli;
2. A middle area, in which there is sensitivity to only blues and yellows, as well as light stimuli; and
3. An outer area, where there is sensitivity only to light stimuli.

These are called the *color zones*. Color blindness may be total or partial and when partial it is related to the color zones. There are few authentic cases of yellow-blue color blindness, while red-green color blindness is present in 3 to 8 percent of males and 0.1 to 1.0 percent of females.

C. Qualitative Differences in Visual Sensitivity

There are three qualitative dimensions in vision: *hue, brightness,* and *saturation,* although brightness and saturation may be thought of as quantitative variables of hue. The visual qualitative attributes are represented graphically in Titchener's *color pyramid*. Hue differences are changes in color tone. Changes in hue run in five lineal series: white-black, red-yellow, yellow-green, green-blue and blue-red. Changes

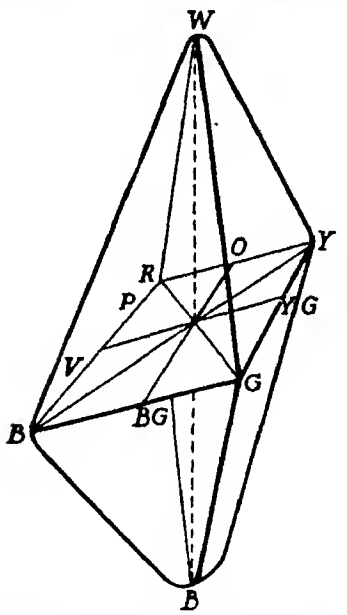

Fig. 2. *Titchener's Color Pyramid* (after Titchener, *Textbook*, 1910) represents graphically the qualitative relationships of visual hues, saturations, and brightnesses. The double pyramid shows two mutually related systems of sensitivities: a system of light sensitivities and one of color sensitivities. Hue is color-tone. Black and white are hues, as are all of the colors. Saturation is the variable representing the degree of the hue. The light system introduces the variable of brightness into the color series. The variables of saturation and brightness are reduced to one variable in the consideration of the light series. The R-Y-G-B parallelogram can be represented with varying degrees of brightness at any point between black and white. Neutral gray (brain gray) is represented at the mid-point and black has many undistinguishable hues.

in brightness of hues do not change the hue, but add white or black. Changes in saturation do not change the hue and there will be no change in brightness of the R-Y-G-B series (see pyramid) if the stimulus is corrected in illumination. Such changes increase or decrease the amount of color, which is a change in color-depth or an increase or decrease of neutral gray. There are approximately 35,000 elemental visual sensitivities of which 160 are distinguishable hues and 600 are distinguishable brightnesses. Titchener has formulated the following laws for the mixing of color stimuli to cause the different color sensitivities:

1. For every color there is another *complementary* (*antagonistic or opposite*) *color,* which if mixed with it in the proper proportions produces a sensitivity of gray and if

mixed in any other proportions a color sensitivity of low degree of saturation and of the hue of the stronger component.

2. The mixture of any two colors, which are not complementary, produces a color sensitivity of intermediate hue. This hue varies with the relative amounts of the two component colors, and the saturation varies with their nearness or remoteness to gray.
3. If two color mixtures arouse the same visual sensitivity, a mixture of these mixtures will also arouse the same color sensitivity (Newton's Law, 1704).

D. Intensity

The least intense visual sensitivity is present in the dark adapted eye. The measure of strength of stimulus is called the *absolute light-threshold*. This threshold is raised 10,000 times for a just noticeable visual sensitivity in the light adapted eye. This is due to the high adaptability of rod-vision. In the rod-free *fovea* the threshold increase for the light adapted eye is about 100 times that for the dark adapted eye. In the absence of environmental stimulation there is visual sensitivity termed *self-light*, which is a neutral gray. Intensity differences above the absolute threshold are measured in terms of *JND* (just noticeable differences). The minimum change in strength of stimulus that is just noticeable is called the differential limen (or threshold).

E. Visual Extensity

Visual sensitivities have the dimension of extensity or spatial and distance characteristics. Visual sensitivities are mass awarenesses and they spread out over space and into foreground and background. Motion is due to a succession of visual sensitivities.

III. AUDITORY SENSITIVITY (HEARING)

Audition is a distance awareness. The receptor (the ear) is highly specialized for the analysis of auditory stimulation.

A. Stimulation

Stimulation of hearing, or audition, is by vibrations of the air, or other physical media, which are called 'sound waves.'

1. Composition of Sound Waves. Sound waves may be either (1) periodic or (2) non-periodic, and the periodic may be either (1) pendulum or (2) non-pendulum in composition. Non-periodic sound waves stimulate noise sensitivities. Periodic non-pendulum vibrations stimulate compound tones. Pendulum vibrations (sine waves) stimulate pure tones. These are the usual correlations between stimuli and sensitivities, but there are many exceptions.

2. Frequency of Vibrations. All sound waves travel at a uniform rate in the same medium, and in dry air of 32° F at about 1087 feet a second (331.29 meters). Sound waves are like ripples in the water and the length of the waves (from one crest to the next) determines the number of vibrations to arrive at a given point in a certain time. One vibration includes both the crest and the valley of a wave and is called a *double vibration* (d.v.). Different frequencies determine the pitch of sound (called *vibration frequency*). Amplitude of the vibration, i.e., the height of the crest and depth of the valley, determines the intensity, or loudness, of the auditory sensitivity.

B. Receptors

The specialized sensitive structure of audition is the *organ of Corti* of the internal ear. Audition is a mechanical process of analysis in which the very complicated accessory apparatus of the ear is essential structure. Sound vibrations in the air are assembled in the concha (shell) and meatus (tube) of the outer ear and are transmitted to the tympanic membrane (ear-drum). When the tympanic membrane is in vibration it causes the attached bones (hammer, anvil, and stirrup) of the middle ear to vibrate, which in turn cause the attached membrane of the oval window of the cochlea of the inner ear to vibrate. The inner ear has two labyrinths, one the organ of equilibrium, and the other the cochlea of audition. The cochlea resembles a snail's shell and has an ascending and descending canal filled with perilymph (liquid). The ascending canal begins at the oval window, which is stimulated into vibration by the bones of the middle ear and in turn stimulates the perilymph. The descending canal ends at the round window, near the entrance to the Eustachian tube of the middle ear, which dampens any vibrations reaching it. The ascending canal and the descending canal are connected at the superior end so that vibrations travel throughout the liquid medium. A membraneous labyrinth (the cochlear duct) separates the ascending and descending canals. It is filled with endolymph, which is stimulated into vibration by the vibration of the perilymph of the canals. The organ of Corti is situated on the membrane (basilar membrane) and the different cells of this organ are stimulated by the various frequencies of vibrations of the endolymph. Thus the ear is a physical analyzer of sound. Nerve fibers of the auditory nerve surround the base of the hair cells forming the organ of Corti.

C. Qualitative Differences in Auditory Sensitivity

Auditory sensitivities are composed of noises and tones.

1. Noise. Noise is stimulated by a complex of mixed frequencies (periodic vibrations) or by a single frequency (non-periodic vibration) of less than two vibrations. Pure noises, or pure tones, are rare.

2. Tone. Tone is stimulated by two or more waves of the same frequency when more than 12 d.v. per second.

3. Tone Qualities. The auditory qualities of pure tone are *pitch, volume,* and *octave.* These qualities are observable in both noise and tone. Volume and octave are variables of pitch. Pitch is the scaling of tone and depends upon frequency of vibration. The lowest limit of pitch sensitivity is between 12 d.v. and 20 d.v. per second. The highest limit is in the neighborhood of 20,000 d.v. per second. About eleven thousand different pitches can be distinguished. But there are wide individual differences in ability to discriminate between pitches. We are aware of volume in narrowness and diffusion of tone. This quality must not be confused with intensity of tone and its relation to pitch is graphically represented in Titchener's *tonal pencil* (Textbook, p. 94). Octave (tonality) is observed in the recurrence of the same quality of pitch at a higher or lower level. It is present where the vibration rate is doubled or halved.

4. Tonal Fusions. Complex tones are a fusion of many frequencies giving a unitary awareness. Tonal fusions form the basis of harmony. In general, the simpler the numerical ratio of two vibration frequencies, the closer the harmony of the fusion.

5. Clang. Tones of ordinary experience are *compound tones.* They are a complex of *fundamental* and numerous *overtones.* This is called *clang.* The overtones are halves, thirds, fourths, fifths, etc. of the fundamental. The stimulus is a non-pendulum vibration of related partials or sine waves. The mathematical statement of stimulus relations is called *Fourier's Theorem.* The conscious analysis of the clang into fundamental and overtones is called *Ohm's Law.* These two laws complement each other. A pure tone seldom exists, but a tone can be produced with overtones of very low intensity with the *Quinke Tubes.*

6. Timbre. Different timbres are due to the number of overtones, which are caused by the resonators of various musical instruments.

7. Beats. When two clangs with fundamentals of slightly different vibration frequencies are sounded together there is awareness of *beats.* The number of beats per second is the vibration difference between the two frequencies. Beats of about 6 per second form a third tone called an *intertone,* which has a pitch intermediate between the two frequencies. Frequencies with a difference of more than 30 per second form a combination or difference tone.

8. Combination Tones. Two clangs, when combined, form many other tones, either in the receptor or in the explicit environment, some of which can be heard by the untrained observer. These are *combination tones,* which are formed both between the various overtones and between the fundamentals of the two clangs. Helmholtz reports having heard 6 different tones from the combination of two clangs. The frequency of a combination tone is equal to the difference between the frequency of its two registers.

Helmholtz has reported a *summation tone,* which is the sum of the frequencies of its two registers. A few observers have verified this existence.

D. Protensity and Rhythm

Auditory rhythm depends primarily upon differences in time (protensity dimension), although intensity and pitch are distinguishing dimensions of this complex sensitivity. But all rhythm has an individual origin in sensitivities from the various muscles and organs of the body.

E. Intensity

The absolute threshold of auditory sensitivity varies greatly with pitch. It is high for low and high frequencies and least for frequencies between 1000 and 2000 d.v. per second. J N D in auditory intensity in the two receptors related to one stimulus are cues to spacial localizations. Accuracy is greatest when the stimulus is nearer one ear than the other. The head is moved as an aid in spacial interpretation.

F. Extensity

Besides these intensity cues localization of sound is dependent upon *phase* and *time* of arrival of the frequency in the two ears. The *complexity* of the tone is an important cue to localization of tone.

IV. OLFACTORY SENSITIVITY (SMELL)

Olfaction, like vision and audition, is a distance awareness.

A. Stimulation

Stimulation of smell, or olfaction, is by gaseous substances. Stimulation may be either in the external or internal (alimentary tract) environment.

B. Receptors

The receptors of olfaction are in the two *Schneiderian membranes* situated at the uppermost part of each nostril. Nerve cells form the sensitive tissue, called the *olfactory bulbs*. The organization of structure is similar to that of vision, but quite different from audition, and olfaction is thought of as a chemical process. It is also believed by some

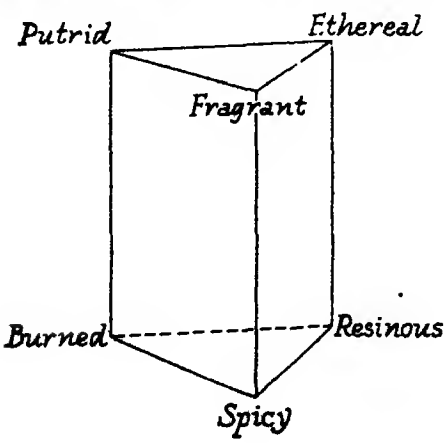

Fig. 3. *Henning's Odor Prism* (*after* Henning, *Der Geruch*, 1916), representing the different olfactory qualities, which are said to grade off into each other. The prism is hollow and all odor qualities can be represented upon its surface.

investigators that different olfactory bulbs are specialized for the reception of different gaseous substances.

C. Olfactory Qualities

Olfactory qualities are called *odors*. An exact list of simple odor qualities has not been established, but research indicates that elemental qualities exist and combine into complex odors. Henning (1915) gives six elemental odor groups, as follows, (specific stimuli are given in parentheses):

Fragrant or flowery (heliotropine)
Ethereal or fruity (lemon)
Foul or putrid (rancid cheese)
Aromatic or spicy (anise)
Balsamic or resinous (camphor)
Empyreumatic (tar)

The field of olfaction in very inadequately explored due to the difficulty of experimental control.

D. Intensity

Intensity is measured either by the concentration of solution or by area of surface of the stimulus substance. The absolute threshold of concentration varies widely for various substances and is as low as 0.000,000,000,000,043 gm. per c.c. of air for mercaptan. For surface areas the unit of measurement is the *olfactie*, which is the area of the stimulus for the absolute threshold. Surface measurement is performed with the *olfactometer* and 1.76 sq. cm. is the olfactie for india rubber.

E. Extensity

Differences in intensity in the receptors of the two nostrils gives to olfaction an interpreted dimension of extensity. The head is moved to check upon the spacial interpretations in olfaction.

V. GUSTATORY SENSITIVITY (TASTE)

A. Stimulation

Stimulation of taste is by substances in solution which enter the mouth cavity. Taste is not a distance sensitivity.

B. Receptors

The receptors of taste are small bulbs which are located in the circumvallate and fungiform papillae on the surface of the tongue and the mucous membrane of other parts of the throat and mouth. There is a small opening at the neck of the bulb into which the taste stimulus must go before there is reception of stimulation by the taste cells in the walls of the bulb. Fibers of the nerves surround these cells.

C. Gustatory Qualities.

Gustatory sensitivities have four qualities: bitter, sour, sweet, salt. Combinations of these with pressure, warmth, cold, pain, and the different odors give us many of our complex mouth awarenesses.

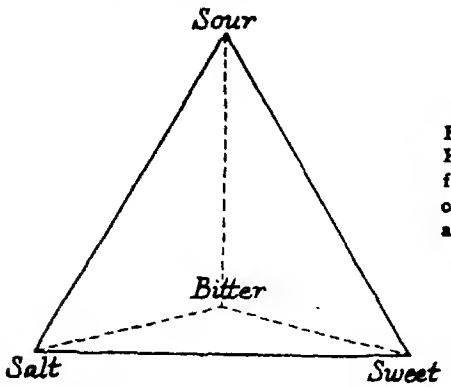

Fig. 4. *Henning's Taste Tetrahedron* (after Henning *Der Geruch*, 1916) representing the four taste qualities which are said to grade off into each other. The figure is hollow and all tastes can be represented upon its surface.

D. Intensity

Differences in intensity are directly related to the strength of the stimulating substance. The least intensity for each of the taste qualities is shown in the following table (Sanford).

Quality	*Substance*	*Dilution in Water*
Bitter	Quinine	1:390,000
Saline	Salt	1:2,240
Sour	Sulphuric Acid	1:2,080
Sweet	Sugar	1:199

E. Extensity

Extensity is quite unimportant in gustatory sensitivity, for taste is not a distance receptor. But we are aware of extensity when the same substance, or two different substances, stimulates different bulbs upon the surface of the tongue.

VI. EQUILIBRIUM (STATIC) SENSITIVITY

A. Stimulation

The stimulus for equilibrium sensitivity is any change in the position of the body, particularly the head.

B. Receptors

The reception of equilibrium, or static sensitivity, is located in the internal ear in the semi-circular canals, and in the vestibule with its two membraneous sacs, the utricle and saccule. These special receptors of equilibrium have been experimented upon by numerous methods to determine their contribution to awareness. The otoliths

are particles of calcium carbonate embedded in the hair-cells of the utricle and saccule, which may function in a mechanical manner in equilibrium sensitivity. The general theory of equilibrium sensitivity, however, states that endolymph in the semi-circular canals and the vestibule stimulates crastae and maculae (hair-like organs in the walls) by its movement. This movement of liquid is caused by the motion, or change of position of the body. The maculae and crastae are the sensitive receptive apparatus and the nerve fibers are in functional contact with these organs. The three semi-circular canals are in different planes and the endolymph moves in one or more planes for any movement of the body.

C. Equilibrium Qualities

Equilibrium sensitivities are said to have two qualities, *position* and *movement,* but the question is unanswered whether or not there are qualitative differences in equilibrium or if these are extensity differences. Both position and movement depend upon changes in the endolymph. Equilibrium is not a distance sensitivity.

Complex equilibrium sensitivities are closely related to the *kinesthetic sensitivities* which are stimulated in the joints and muscles. Both contribute to the total complex awareness of position and movement. Also, awareness of nausea and dizziness are partially equilibrium sensitivities.

D. Intensity

Intensity differences are observable in equilibrium sensitivity. A change in speed of movement of the endolymph is correlated with a change in intensity of the awareness.

The sensitivities which have been studied up to this point, are all special sensitivities with highly specialized receptor mechanisms. The less specialized, or general sensitivities, are the cutaneous, kinesthetic, and organic sensitivities.

VII. CUTANEOUS SENSITIVITIES

In popular parlance the cutaneous sensitivities are referred to as touch. They are contiguous sensitivities.

A. Stimulation

The stimulation of the cutaneous sensitivities is by surface contact.

B. Receptors

The cutaneous receptors and all of the receptors of the special sensitivities, excepting equilibrium, compose the group called exteroceptors.

It is found that the surface of the skin is not uniformly sensitive to stimulation, that there are insensitive areas, and that the sensitive surfaces have a degree of specialization. Specialized spots are found for pressure, pain, warmth, and cold, and most cutaneous awareness is a combination of these sensitivities. Receptors have been segregated for each of these specialized sensitivities, but the sensitivity can more accurately be related to the stimulus spot than to any receptor. Receptors for the various specialized cutaneous sensitivities, reported by various investigators, follow:

Sensitivity	*Receptor reported to be correlated with sensitivity*
Pressure	Hair bulbs Meissner corpuscles Merkel Corpuscles
Pain	Free nerve endings
Warmth	Ruffini cylinders (Free nerve endings)
Cold	Krause end-bulbs (Free nerve endings)

The hair bulbs for pressure and the free nerve endings for pain are most conclusively established as cutaneous receptors.

C. Cutaneous Qualities

The four sensitivities may be thought of as different cutaneous qualities, although qualitative differences are reported between various pressures, pains, colds and warmths.

1. Pressure. Pressure spots vary widely in density for various areas of the body, with an average of about 25 per sq. cm. Stimulation of individual pressure spots is accomplished with the *von Frey hair.* There are differences in intensity for various areas. Density tends to increase and the absolute threshold tends to decrease with areas toward the periphery. Pressure has spatial and movement sensitivity.

2. Pain. Pain spots have a greater density than pressure spots and they vary widely in density for various areas of the body, with an estimated average between 100 and 175 per sq. cm. The stimulation of pain spots is accomplished with the von Frey hair. The absolute threshold for pain is lower for areas with greatest density of spots. Unpleasantness, often associated with pain, is not necessarily a part of pain sensitivity.

3. Cold. Temperature spots are stimulated with a *temperature cylinder.* Cold spots vary in density for various areas of the body, with an estimated average from 7 to 13 per sq. cm. The temperature range for cold stimulation is usually from -10° to 30° C. with varying *physiological zeros* of psychological indifference according to adaptation conditions. A *paradoxical* cold is stimulated at 45° to 70° C. The lowest absolute threshold is 0.033°, but it varies for conditions of adaptation, and the differential limen of JNDs, which varies for different areas, is several times this quantity.

4. Warmth. Warmth spots vary in density with area, and according to the kind of stimulation. With punctiform stimulation they are about as numerous as cold spots. The temperature range for warmth is usually from 35° to 70°C with varying physiological zeros according to adaptation conditions. A paradoxical warmth is stimulated at 25° to 31°. The absolute threshold and differential limen for warmth are much the same as for cold.

Heat is regarded both as a fusion of warmth and cold and as an unanalyzible quality which is correlated with warmth and cold stimulation. The best condition of heat is warmth stimulation at about 45° C, where paradoxical cold is a part of the sensitivity. Pain is a part of the heat sensitivity for higher temperatures. Heat is sensed for cold stimulation at 25° to 28° where paradoxical warmth is a part of the sensitivity. Heat is also sensed with a combination of warmth stimulation at 38° and cold stimulation at 20°.

5. Complex Cutaneous Sensitivities. Numerous complex sensitivities (touch blends) are reported to be combinations of the four cutaneous qualities. Among them are:

(1) Sharp and blunt = pain and pressure,

(2) Clamminess = cold and pressure,

(3) Wetness = pressure and warmth or cold,

(4) Intense cold = cold and pain, and

(5) Intense heat = cold (paradoxical), warmth and pain.

VIII. KINESTHETIC SENSITIVITIES

The kinesthetic (sometimes called motor) sensitivities are localized in the muscles, tendons, and articular surfaces of bones.

A. Stimulation

Stimulation of kinesthetic sensitivities is by contact, usually resulting from postural changes of the body, in the muscles, tendons, and joints.

B. Receptors

Receptors reported for the muscles, tendons, and joints include the free nerve endings, the Pacinian corpuscles, the muscle spindles, and the tendon spindles. These receptors, along with the receptors for equilibrium, form the group called proprioceptors. Almost nothing is known, with any degree of exactness, of the correlation between kinesthetic sensitivities and receptors. It seems probable, however, that the free nerve endings have the same function as in the cutaneous surfaces and mediate pain, while the other receptors mediate pressure.

C. Kinesthetic Qualities

The muscular, tendinous, and articular sensitivities are regarded, sometimes, as kinesthetic qualities, but the true qualities are pressures and pains. Sensitivities of warmth and cold are not found in the muscles, tendons, and joints.

D. Intensity and Extensity

The absolute threshold of kinesthetic sensitivity has been determined as less than one degree of movement for most joints. Investigations into the relative significance of muscular, tendinous, and joint sensitivities show diffused localizations and the conclusion is drawn that muscular sensitivity is most important in the awarenesses of deep pressure and the tendinous and articular sensitivities are more important in movements and lifted weights.

IX. ORGANIC SENSITIVITIES

The areas of organic sensitivity are the mucous membraneous surfaces of the respiratory, alimentary, genital, and urinary systems, and the surface linings of organs and tissues of the thoracic and abdominal cavities. Organic sensitivities are said to be due to the stimulation of interoceptors. Many organic sensitivities are not localized with any degree of exactness, but are experienced as diffused feeling.

A. Stimulation

Stimulation is by contact, as in cutaneous and kinesthetic sensitivity, and is due to the movement of various surfaces upon each other or by substances in the various vegetative systems.

B. Receptors

No receptors have been segregated for the general organic sensitivities. Taste and smell, in so far as they are stimulated internally, may be regarded as organic sensitivities, which have, of course, special receptors mediating these awarenesses.

C. Organic Qualities

The organic qualities are thought to be the same as those of the cutaneous sensitivities: pressure, warmth, cold, and pain. Organic warmth and cold sensitivities are not so numerous as pressure and pain, but there are sensitive areas of warmth and cold in the surface linings of the upper part of the alimentary tract and in the rectum.

D. Complex Awarenesses

There are numerous complex awarenesses caused by the stimulation of interoceptors.

1. Thirst. Thirst is an awareness of pressure (and pain under extreme stimulation) reported as localized on the tongue, roof of mouth, and throat. What makes it a 'thirst' is the total situation and includes memory of stimuli relieving the condition.

2. Hunger. Hunger is also a complex of pressure and pain referred to the region of the stomach. Here, again, it is the total situation that makes this particular pressure-pain a hunger.

3. Nausea, Defecation, and Urination. These complexes are reducable to pressures and pains with the total situation responsible for what the awareness is called.

X. FATIGUE OF SENSITIVITY

There are two forms of fatigue of sensitivity: physiological and psychological fatigue.

A. Physiological Fatigue of Receptor

A fatigued condition is present when stimulation is continued over an abnormally long period. Sight appears dim, the eyes do not focus upon the stimulus. We do not hear the sounds which ordinarily would be heard. In experiments with pressure, pain, and temperature, often there is reported to be no sensitivity where it was present before fatigue set in. This form of fatigue is referred to as the physiological fatigue of receptors.

B. Psychological Fatigue

Another form of fatigue of sensitivity is related to the focusing of awareness. The eyes do not focus upon the page because this sensitivity has lost its ascendency in awareness. Other awarenesses are more prominent. The same is true of other departments of sensitivity. This form of fatigue is referred to as psychological fatigue, or the fatigue of intent (sometimes called the fatigue of attention).

XI. SENSITIVITY ADAPTATION

There is a tendency for all sensitivities to return to a neutral or non-awareness condition. This is called *adaptation*. Sensitivity grows less and less until there is complete adaptation in what might be called an equilibrium of sensitivity. There are wide differences between departments of sensitivity in the rate of adaptation. In auditory sensitivity adaptation does not exist. In pain, adaptation takes place only under conditions where the stimulus maintains a constant intensity, which is unusual. In temperature it does not exist for large areas of the body.

A. Temperature

Temperature adaptation is illustrated by placing one hand in a container of warm water (about 40° C) and the other in a container of cold water (about 20° C). Soon there is indifference and the receptors in both hands are at physiological zero. Now, if both hands are placed in a container of water at 33° C (normal physiological zero of hands) one hand feels cold and the other warm (this experiment illustrates that adaptation is not fatigue of receptors). Temperature

adaptation establishes physiological zeros for temperatures as low as 16° C and as high as 44° C. It is complete for punctiform stimulation in 4 to 97 second for cold and 2 to 68 second for warmth (Dallenbach, 1927). Adaptation is not complete for large areas, as with cold feet, but large area adaptations do take place so that extreme temperatures which have been unpleasant become indifferent or pleasant.

B. Pressure

Adaptation in pressure sensitivity is very rapid and complete. We are not aware of our clothing, the pressure of our glasses, or the pressure of the chair in which we sit.

C. Olfaction

Adaptation to odors is fairly rapid and is complete in 3 to 12 minutes with variability for different odors. Recovery is in about 5 minutes.

D. Gustation

Adaptation to taste is slower than for smell, but complete adaptations are evident for all the four qualities. Wine, which tastes mildly sweet during the main course of a dinner, tastes sour later in the meal when sweets are being eaten. Oyster stew, which has the desired salty taste upon beginning to taste it, requires more salt later on to satisfy us. Adaptation of taste is unitary, as far as the four taste sensitivities are concerned. Adaptation to bitter may abolish the taste of bitter, but the other sensitivities of sweet, sour, and salt remain unchanged.

E. Vision

Adaptation in visual sensitivity is highly complex and involves both brightness and saturation. General adaptation phenomena are evident on coming from a well-lighted and color-full room into a dark room. Adaptation tends towards the neutral gray of self-light, but adaptation is seldom complete. Threshold differences for various conditions of adaptation have been given as ratios of one to ten thousand for rod-vision and one to one hundred for cone-vision, thus adaptation for light (brightness) is much greater than adaptation for color (saturation). Special adaptation phenomena are called after-sensitivities and related to visual adaptation are contrast-effects.

1. After-Sensitivities. After-sensitivities (frequently called after-images and after-sensations) are of two kinds, positive and negative. The positive after-sensitivity is of the same hue, brightness, and saturation as the original sensitivity and may be thought of as a prolongation of the sensitivity after a slight interval of time following the removal of the stimulus. The negative after-sensitivity is of the antagonistic hue, brightness, and saturation of the original sensitivity (see Titchener's Color Pyramid) and follows the positive after-sensitivity after a brief interval of time.

2. CONTRAST-EFFECTS. The hue, brightness, and saturation of a sensitivity affects, and is affected by, the hues, brightnesses, and saturations of all the surroundings. Each brightness reduces the brightness of the other. Each hue induces its complementary in the other. Saturation determines the degree of this induction of hue and increases the saturation of each. Titchener gives five laws for contrast effect (*Textbook* p. 76).

F. Kinesthetic and Organic

Kinesthetic and organic sensitivities are analogous in adaptation to pressure, pain, and temperature and would appear to follow the general rules of adaptation for these sensitivities.

G. Equilibrium

Equilibrium sensitivity shows a high degree of adaptation, which takes place fairly rapidly, but this is not a true adaptation phenomenon. The child when circling rapidly, in play or on a merry-go-round, soon adapts to the movement, but when the motion stops he has difficulty in maintaining his position until 'adaptation' again takes place. This is due to a change in stimulation. The receptive apparatus in the internal ear is subject to a change in stimulation upon movement or discontinuing movement of the body. True adaptation in equilibrium takes place very slowly and is evident in crossing the ocean, or in riding in aeroplanes, where there is no awareness of equilibrium changes.

XII. SENSITIVITY IS MASS ACTIVITY IN AWARENESS

Never are visual sensitivities alone; nor are auditory, or temperature, or pressure, or pain, or taste, or smell, or kinesthesis, or organic, or equilibrium. What makes them appear as if they were alone is the focusing of individual sensitivities in awareness. Certain sensitivities seldom reach the focus of awareness (often called attention). This occurs within a department of sensitivity, such as vision or audition. Then, certain departments of sensitivity as a whole are less likely to be focused in awareness, as with equilibrium. They are said to be subconscious, or even unconscious. But awareness is always total, while certain sensitivities, or departments of sensitivity, may focus. Sensitivity is mass activity in awareness. It is the conscious integration of the effect upon the organism of environmental stimulation. Later, recalled sensitivities add to the complex and make possible thinking in relation to immediate sensitivities.

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CHAPTER III

REACTION

Psychological activity conforms to a formula (S-I-R) in which stimulation, integration, and reaction are the essential divisions. Stimulation passes over into integration as the individual is aware of physical and chemical changes. This activity is studied as sensitivity. Reaction is the resultant of stimulation and integration, and reaction may be related in time to both the stimulus and the sensitivity. But the essential purpose of the study of reaction is to understand its organization or form, its development, and its correlation with effector structures.

I. GENETICS OF REACTION

The organism's reaction capacities are the joint products of inheritance and learning. The organism does not react separately with inherited reactions and with learned reactions. The reaction of an organism at any moment is the resultant of what has gone before in development, which is a genetic growth of both heredity and environment.

Reactions are often classified genetically into *native* and *learned reactions*. The former are said to be due to inheritance causes, and the latter to environmental causes. But learning begins immediately with the first reaction. Reactions may be classified, then, as primarily native or primarily learned, according to the amount of the influence upon the reaction of either heredity or environment. This classification, then, is an arbitrary one. The evidences of heredity are never observed until they are submitted to the stimulation of environment and the two factors, heredity and environment, work hand is hand in the genetic development of reaction.

II. MATURATION OF REACTIONS

In every living cell there is a capacity to develop under stimulation. Cells mature and are kept in condition by metabolic activity. When cells mature in relationship to other cells an organ or structure is formed. The maturity of a certain structure in relation to other structures carries with it the capacity for psychological reaction.

A. Experimental Investigations of Maturation

The earliest experimenter in this field (Spaulding, 1873) worked with swallows, confined them in cages where they could not exercise their wings, and found that they flew when released after the time most birds fly. He also attached blinders to the eyes of chicks so they could not see to peck and found, when these were removed after several days, that the chicks pecked as did other chicks who had exercised this reaction. Carmichael (1928) placed frog eggs in two dishes, one with plain water and the other with an anesthetic: after a period the tadpoles in the dish of plain water swam about while those at the same stage of structural development in the drugged water remained motionless. Substituting plain water for the drugged water, these tadpoles swam without opportunity of learning.

B. Maturation, A Genetic Process

Reaction capacities for various structures do not mature at the same time. Some mature, like the capacity to breathe in the child, before birth. Some mature, like the capacity to walk, after birth. Birth is but a step in the maturation process. Learning begins in embryo life.

C. Maturation Differences Between Species

The genetic development of reaction capacities is different in different species. The guinea pig is very nearly mature after the first day of life. The cat takes about 25 days to reach the same stage of maturity (Tilney and Kubie, 1931). Kellogg and Kellogg (1933) reared an ape and a child together and showed, among other things, that the maturation of reactions in the ape was much more rapid and complete than in the child at the same age.

D. Conclusion on Maturation

The influences of heredity are expressed in the maturation of structures with capacities of reaction. Reaction capacities mature as units of behavior and a reaction takes place when the appropriate stimulus occurs. However, a high degree of efficiency is not present in a reaction upon its first expression. Learning (exercise) under stimulation of the environment is necessary to perfect reactions.

III. THE INVESTIGATION OF NATIVE REACTIONS

Reactions are referred to as native reactions if they are expressed without evidence of learning and are universal for a species under the same stimulation and at the same stage of maturity.

A. In Animals

Certain specific stimuli are found to evoke a native reaction in animals. Others do not. The clucking of a hen is not a stimulus to a native reaction in chicks. Any small object will cause a hungry chick

to peck. But the pecking in chicks is not perfect upon its first appearance. Nor is there any discrimination on the part of the chick of food and non-food objects. Water is not a stimulus to the drinking reaction, unless it is placed in the bill of a thirsty chick. Thirsty chicks will run through water without drinking and unless they chance to peck at objects in the water, thus getting water in the bill, they do not drink (Lloyd Morgan, 1894). The discrimination of objects must be learned and reactions must be perfected through exercise.

B. In Humans

The situation is much the same with humans as with other animals, only the native reaction mechanisms are less perfect and learning is more important to life. Many native reactions are observed to mature after birth in the human. Important observations in this field are reported by Gesell, Johnson, Jones, I. and M. Sherman, and Watson.

IV. THE REFLEX

All native pattern reactions of organisms possessing a nervous system are reflexes. In the higher organisms the reflex involves receptors, afferent neurons, adjustor neurons, efferent neurons, and effectors in functional relation. The term, reflex, is applied sometimes to reactions called *tropisms* in organisms not possessing a nervous system.

A. Definition

A multitude of reaction capacities result from the maturation of structures. Watson (1919) states that there are enough, and more, to perform all of the complex activities of adult life, once integrations or connections are established between stimulus and reaction. No specific reaction exists for most environmental stimuli and the reactions caused by general stimulation are called *random reflexes*. Random reflexes are the basis of learned activity.

The term reflex is reserved, usually, for pattern reactions where integrations between stimulus and reaction are established, or partially established, by heredity. These reflexes, such as the eyelid reflex, are limited in number. The stimulus is always the same and one pattern reaction completes the activity. Warren (1922) has defined the reflex as "a definite response to a definite stimulus, due to an inherited arrangement of nerve paths." The reflex is a native simultaneous pattern reaction of varying degrees of perfection, which is causd by a definite kind of receptor activity.

B. Classification of Reflexes

Reflexes may be divided into explicit and implicit reactions, according to the position in the body and the kind of the effector. Explicit reflexes involve striated muscle effectors and act upon the external

environment. The implicit reflexes involve the unstriated muscle and gland effectors and act upon the internal environment of the organism. The implicit reflexes are frequently spoken of as *automatic* activities. They operate largely under stimulation through the *sympathetic nervous system*. Other classifications of reflexes are based upon complexity: (1) simple and compound, (2) antagonistic and allied. Warren (1922) has classified reflexes according to their genetic, or developmental, possibilities in the individual, as follows: (1) Those least subject to modification; (2) Those subject to slight reinforcement or inhibition; (3) Those usually subject to modification; (4) Those modified in the adult but found pure in infancy; (5) Those found in the adult, but not in infancy. A long list of reflexes is included in this classification. All of them are quite specific upon their first stimulation and evidently dependent upon the maturation of structure.

C. Features of Reflexes

Several conditions of reflex activity exist, as follows:

1. Threshold of Stimulation. A certain intensity of the stimulus is required to induce a reflex. The amount required is spoken of as the threshold.

2. Localization of Stimulus. The reflex reaction depends upon the area of stimulation.

3. Intensity of Stimulation. As a rule less intense stimuli induce a weak reaction. Stimuli of greater intensity cause a stronger reaction. The reaction varies somewhat with the intensity of the stimulus.

4. Inhibition in Reflex Activity. In the reflex certain antagonistic effectors are innervated, which inhibit or control the reaction.

V. TIME OF REACTION

Human nerve conduction is at a rate of about 12 cm per ms. Reflex reactions are completed in about twice this time, for example, the eyelid reflex requires about 30 ms and the knee-jerk reflex requires about 50 ms. This difference is said to be due to the slower functioning of receptors, effectors, and synaptic contacts in the nervous system rather than the neurons themselves. The time interval between presentation of a prescribed stimulus and the intended reaction is called the *reaction time* and is interpreted as the time of integration between S and R.

A. Simple Reaction Time

Simple reaction time is the time required to react where there is only one possible stimulus to the prescribed reaction. The average times vary for different individuals and for different sensitivities, and have been established as follows: vision, 150-225 ms; audition, 120-180 ms; touch, 117-182 ms; warmth, 180 ms; cold, 150 ms; and pain, 400 ms. These reaction times would not exceed 20 ms if the only factor involved were nerve conduction.

B. Complex Reaction Time

In the *discrimination* and the *choice reaction* the observer makes either one prescribed reaction to one of several stimuli, or one of several prescribed reactions to one of several prescribed stimuli. The reaction time is lengthened in accordance with the complexity of the situation.

In the *associative reaction* the observer is required to form an association (verbal reaction) to a stimulus word; the average reaction time is about 2000 ms.

VI. CONDITIONED (LEARNED) REACTIONS

Under the influence of environmental stimulation the organism reacts according its capacities for reaction, which are the product of maturation and learning. Reactions may be learned in two ways. A new or reorganized pattern of reactions may be connected (associated) with an adequate stimulus to reaction and a new or *conditioned stimulus* may be connected with an existing reaction, replacing the previous adequate stimulus.

A. The Conditioned Reflex

The reaction which is established as a response to the conditioned stimulus has been called the *conditioned reflex* (*C.R.*), because experimenters have been concerned largely with the reflex. However, conditioned reactions are formed with well established learned reactions where new and indifferent stimuli are associated and then substituted for the adequate stimuli to the reactions. The C.R. mechanism operates at all levels of development of reaction.

Pavlov, a Russian physiologist, working upon the salivary reflex in dogs, and Twitmyer, an American psychologist, working upon the patellar reflex, were the earliest investigators (about 1900). Pavlov's classical experiment is described. A hungry dog was placed in a harness and stood on a table. A bell was sounded (the indifferent stimulus) and a piece of meat (the adequate stimulus) was presented to the dog. The sight of the meat caused the dog's mouth to water. After the stimuli were presented several times the sound of the bell alone would produce the flow of saliva.

B. Conditioned Reflexes in Animals

Conditioned reflexes have been established under such experimental conditions as the following: between pressure to the mouth parts and pressure applied to the foot in snails (Thompson, 1916), between certain vibration frequencies and the acceptance or rejection of food by minnows (Westerfield, 1922), and between the extension of the right hind foot and the acceptance of food by dogs (May and Larson, 1919).

C. Conditioned Reflexes in Children

The Russian, Krasnogorski, made the pioneer study on children (1907). He established such conditioned reactions as the opening of the mouth at the sound of a bell. Mateer (1918) modified and im-

proved his technique and established conditioned reactions between feeding movements and tactual stimuli in children 12 to 89 months of age. She found a correlation between intelligence and facility of the conditioning process.

D. Conditioned Reflexes in Adults

Cason (1922) carried on experiments in which the eyelid reflex was conditioned to sound and in other cases the pupillary reflex was conditioned to the ringing of a bell. Dodge (1924) produced an eyelid reflex from the knee-jerk stimulus and Cytovitch (1917) conditioned vasomotor reactions to a sound stimulus. Thus C. R.s have been demonstrated as possible in unconscious reactions.

E. Temporal Conditions of the Conditioned Reflex

Three temporal conditions exist with respect to the sequence of unconditioned and conditioned stimuli.

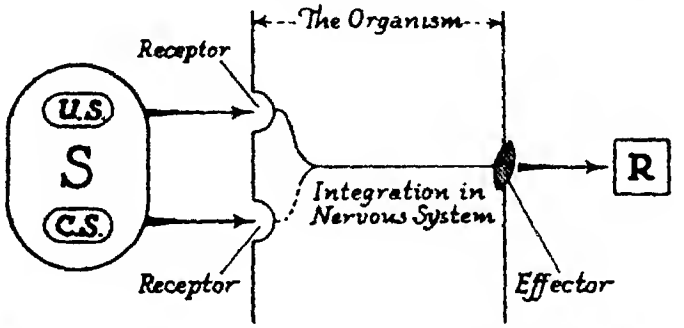

Fig. 5. The Conditioned Reflex, representing graphically the integration or conditioning in the nervous system. The stimulus (S) is a total situation composed of two units; the unconditioned stimulus (U. S.), and the conditioned stimulus (C. S.). These stimuli affect appropriate receptors, and if they occur together repeatedly an integration is effected in the nervous system so that the new or conditioned stimulus innervates the effectors and produces the reaction originally resulting from the unconditioned stimulus.

1. Unconditioned S First. When the unconditioned stimulus is applied first and then followed by the conditioned stimulus, no conditioning takes place.

2. Both S Together. When the conditioned stimulus is given at the same time as the unconditioned stimulus, a conditioning usually takes place if repeated a sufficient number of times.

3. Conditioned S First. When the conditioned stimulus is first applied and after it is withdrawn the unconditioned stimulus is administered, a conditioning frequently takes place in which the time between the conditioned stimulus and the unconditioned stimulus is equalled with considerable exactness by a *period of latency* before the reaction.

F. Deterioration of Conditioned Reflexes

The conditioned reflex often is unstable in its experimental demonstration. Reenforcement is necessary to continue its functioning. It may be destroyed by a general inhibition resulting from stimulation of diverse sorts, or by a special inhibition.

G. Experimental Investigation of Special Inhibition

Any new stimulus occurring at the same time as the conditioned stimulus may inhibit the reaction. The conditioned stimulus then becomes ineffective. This stimulus is called the *inhibitory stimulus*. Also, a second inhibitory stimulus occurring at the same time as the conditioned and first inhibitory stimulus may interfere with the inhibition and allow the conditioned stimulus to be effective.

VII. THE ORGANIZATION OF REACTION

Any reaction involves numerous effectors, and perhaps all explicit effectors. A reaction is the sum-total of stimulation and inhibition of all effectors, which takes place simultaneously. But a reaction is focused in the activity of a relatively limited number of effectors as efficiency of response is developed. The reaction is defined according to the pattern of these effectors.

A. The Simultaneous Pattern Reaction

The unit of psychological activity has been called a simultaneous pattern reaction. Such activities as the reflex, where the action is complete in one expression, are simultaneous pattern reactions. But little activity of this kind is observed in animal or human behavior. Very early in the genetic development of reaction, either through causes of heredity or environment, serial arrangements of pattern reactions are formed so that one pattern reaction is but a part of a chain of reactions (sometimes called 'chain of reflexes').

B. The Successive Reaction

This succession of pattern reactions, of one reaction leading to another, and so on, until a final pattern completes the series, is called the successive reaction. Numerous pattern reactions are included in the successive reaction. Each pattern reaction in the series may be regarded as a preparatory reaction to the final or *consummatory reaction* which completes the successive reaction.

VIII. INSTINCT, EMOTION, AND HABIT

Earlier contemporary psychologists have had much to say about certain categories of psychological activity called *instinct, emotion,* and *habit*. Instinct, or instinctive reaction, and habit, or habitual reaction,

are successive reactions. Emotion is more nearly a mass of simultaneous pattern reactions, although these reactions may appear as a part of the successive reaction.

A. Instinctive Reactions

Instinctive reactions are said to be a series of pattern reactions organized as a part of the inherited development or maturation of behavior. This form of development is said to be more clearly perceptible in plant and animal life, and it is present in less exact form in human life. But in all cases of the inherited development of instinctive reaction, stimulation of the environment has a share in the development of reaction and as this degree of influence increases the reaction is termed habitual.

1. Observations on Instinctive Behavior. Certain successive reactions are often described as instinctive reactions, such as the formation of a cocoon by insects, and nest building by birds. It is often found that these successive reactions will change in form upon a change in the environment. Other behavior such as the following is often called instinctive: (a) lambing in sheep, where the sheep leaves the flock, makes a bed by pawing the ground, gives birth and licks up the after-birth, cleans the lamb, and returns to the flock, (b) suckling of the child, where the child bends the head to the nipple, grasps it with the lips, sucks, and swallows. These are successions of successive reactions and have been shown to involve learning of environmental stimuli and perfection of pattern reactions.

2. Relation of Instinctive to Learned Behavior. As the early inexact forms of instinctive reactions are developed and changed in stimulation and reaction (learning) they are called habitual reactions. It is doubted by many authorities if reactions are integrated into successive forms by heredity. Learning is said to be necessary to form random reflexes into successive reactions. This is a debatable point. If there is any linkage between the native random pattern reactions, due to maturation, they could be called instinctive reactions.

B. Habitual Reactions

Habitual reactions are successive reactions which have been organized primarily because of stimulation of the environment, although all reaction patterns are caused by heredity and are observable in the maturation of structure.

1. Relation to Random Behavior. Habits start largely in the organization of random behavior. The native random pattern reactions are integrated into learned successive reactions. The elemental reactions are native; the organization is learned.

2. Relation to Instinctive Behavior. If there are native successive reactions they are reorganized early in life. New elements replace old. Old reactions are perfected. The behavior which was instinctive is called habitual.

3. Definition of Habitual Behavior. A habit, then, is a complex system of reactions functioning successively, in which the integration of the separate elements is learned.

4. Classification of Habitual Behavior. There are three forms of habitual behavior: (a) motor habits, including all bodily movements, (b) language habits, and (c) emotional habits. The language habits are based upon the random vocalizations and the motor habits are based in a large degree upon random bodily movements. These forms of habitual behavior are both implicit and explicit.

C. Emotional Reactions

Emotional behavior may be either instinctive or habitual, depending on the amount of learning involved. It is typically a pattern reaction with awarenesses of implicit and explicit activities, and a strong affective element.

IX. SUMMARY

Reaction capacities are inherent in the hereditary development of structure. Pattern reactions mature, due to inheritance. These patterns are perfected through environmental stimulation (exercise). There may be a linkage of pattern reactions into successive reactions as a product of heredity. This point has caused a very lively controversy during the last decade over the nature of instinct. Successive reactions develop in the interplay of heredity and environment and the reaction capacities of an organism at any one time are the genetic development of all that has gone before in maturation and learning.

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CHAPTER IV

PSYCHOLOGICAL DYNAMICS

The central theme of psychological dynamics is causation. A dynamic conception relates all motivational factors in understanding psychological activity. Any unitary cause of psychological activity affecting receptors has been called the *environmental stimulus*. Such a unitary cause in the integration of this activity within the organism has been called the *integrative stimulus*. These unitary causes of psychological activity include all motivational factors such as the innervation of effectors, excitation of nerves, glandular and chemical secretions, the intentional activity of awareness, the established mental sets and attitudes, habitual motivation, the energy changes of receptors and the fatigue of organs, and the physical and chemical changes of the environment. The term stimulus, or stimulating situation, is used to mean the whole complex of environmental and integrative causes of reaction.

I. THE DYNAMIC POINT OF VIEW IN PSYCHOLOGY

There are functional and structural concepts in the study of any science. The structural concept in psychology is illustrated by the pattern of effectors in reaction or by the reported colors of visual sensitivity. The perceptual processes and the reaction patterns are structural concepts. The psychologist, who is observing from the structural point of view, describes and measures these existences for their own sake. But structure is necessary to function. A functional or dynamic concept is illustrated by a pattern of effectors changing the position of the body, or by the colors of visual sensitivity bringing about imagery of a childhood village scene. The psychologist, who is observing from the dynamic point of view, measures and describes existences as causes in relation to their effects. He views structure as a genetic sequence in the motivation of behavior.

II. GENERAL DYNAMIC CONCEPTS

The dynamic concepts of psychology are more difficult to understand than are the structural concepts, for they relate cause and effect.

A. Woodworth's Mechanism and Drive Theory

Woodworth (1917) has outlined the dynamic problems of motivation in his mechanism and drive theory. Mechanism is a concept of limited function. Drive is a concept of more extensive function. The mechanisms of an organism explain how reactions are accomplished. The drives explain why. Drives presuppose the existence of mechanisms. A reflex reaction is regarded as a mechanism. More complicated behavior is caused by drives. A drive is defined as a mechanism which is aroused, but which cannot react until other mechanisms are brought into the reaction.

B. Tendencies to Reaction

While motivation consists of both environmental and integrative stimulation, the essential causes of reaction are within the organism (integrative stimuli). These are called the *tendencies to reaction*. Numerous terms are used to indicate various kinds of tendencies. Some indicate the degree of consciousness present, some the physiological basis of the tendency, and some the correlation with environmental stimuli. All terms have a certain vagueness of meaning due to the inexactness of knowledge of the tendencies to reaction. Such terms as the following are used by various authors to describe the internal aspects of motivation: need, want, 'wish' (Freud), libido (Jung), purpose, motive, desire, inner steer, predisposition.

Tendency has the meaning of persistent direction of activity of an organism under varied environmental stimuli. Motive implies a degree of consciousness of goal, and purpose further implies that the goal is definitely outlined in consciousness.

Intent, mental set, and determining tendency will be used as terms to describe the tendencies to reaction because they have experimental definitions. *Intent* is a specific conscious tendency, usually in relation to an experimental task or problem and is the English synonym for the original German term *Aufgabe*. *Mental set* is a later development of the tendency as the activity continues with less consciousness. It is the English synonym for the German term *Einstellung*. The tendency in successive reactions is called a *determining tendency*.

III. REACTIONS

The simultaneous and successive pattern reactions are characterized primarily by their distinctive motivation. Each pattern reaction has its pattern of stimulation which involves environmental and integrative changes. When one reaction pattern removes the stimulus pattern, as in the simple reflex, a simultaneous pattern reaction is said to have taken place.

A. Motivation of the Successive Reaction

It has been said that successive pattern reactions are formed of closely linked pattern reactions and that each pattern reaction is necessary to the completion of the series. What links the series together is the pattern of stimulation. Each pattern reaction in the successive reaction is a part of the succession of stimulus patterns. This is true in degrees as the successive reaction is perfect in degrees.

The 'mechanism' of Woodworth is the pattern stimulus-reaction. When the reaction pattern removes the stimulus a simultaneous pattern reaction is said to exist. When it does not remove the stimulus pattern, activity continues and a drive is formed. Other pattern reactions take place until a final, or consummatory reaction completes the series. This is a successive reaction. Woodworth's theory classifies a simultaneous pattern stimulus-reaction as a mechanism and a series of successive pattern stimulus-reactions as a drive.

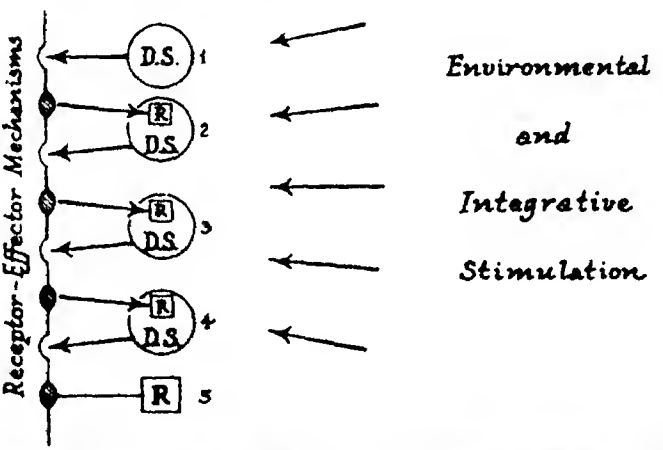

Fig. 6. *The Driving Stimulus of the Successive Reaction.* The original driving stimulus (DS 1) is a total situation composed of environmental and integrative stimuli which can not be removed by one reaction. The pattern may consist of hunger pressures upon interoceptors and sensitivities of the position of the individual in relation to a restaurant. DS 1 acting on receptors causes a reaction R 1 which in turn causes a change in the total situation such that DS 2 differs from DS 1 but again acts on receptors to produce R 2. This reaction changes the total situation to DS 3 and so on. Finally DS 4 produces reaction R 5 which removes the driving stimulus and the successive reaction is completed. The final reaction in the succession is called the consummatory reaction and in this illustration it would be an eating reaction. The driving stimulus of the successive reaction is a developing pattern of stimulation which contains elements that can be removed only through sequential activity.

B. The Psychological Stream

Each series of reactions, called a successive reaction, is, in turn, a part of a larger series. The successive reaction of preparing an assignment in English is a part of a larger series of studying English throughout the year. Other successive reactions, such as studying English,

physics, psychology, German, and so on, are interrelated and form an educational successive reaction. But life is more than this; it is a psychological stream made up of many smaller streams, which in turn are separated into smaller streams. Final subdivisions of psychological activity bring one back to the patterns of stimulation and reaction.

IV. THE DRIVING STIMULUS

Every reaction has a cause in stimulation. The causative factors may be traced to environmental and integrative stimulation. In each case, the stimulating situation includes an essential change which is called a *driving stimulus*. The term, driving stimulus, is introduced to definite that factor in stimulation which is present throughout the successive reaction.

A. The Pattern Stimulus

A simultaneous pattern reaction is caused by a stimulating situation which may be termed a *pattern stimulus*. But in the successive reaction numerous preparatory reactions are caused by numerous pattern stimuli. These single stimulating situations (pattern stimuli) build up from the primary situation to the final situation which causes the consummatory reaction in the series. Each pattern stimulus may be regarded as causing a preparatory pattern reaction in the series.

B. The Driving Stimulus

The driving stimulus is the factor in the stimulating situation that continues from the primary to the final pattern stimulus when a successive reaction is in process. The driving stimulus is what keeps the organism reacting. Important driving stimuli are those of hunger pressure, sex pressure, defication pressure, and so on.

V. CLASSIFICATION OF MOTIVATION

Environmental stimulation affects three types of receptors: interoceptors, proprioceptors, and exteroceptors. The action of environmental stimulation is modified, of course, by integrative stimulation, and motivation of thinking and reacting is the sum of these causes.

A. Physiological Motivation

During early life, one's motivation is largely physiological in nature. This driving stimulation affects interoceptors to a large degree, although exteroceptors have an important place in it. Physiological driving stimuli are the objects and activities (the chemical and physical changes) affecting the receptors of an organism within or without the body. Many of these are spoken of as physiological needs. Some of the more important physiological driving stimuli follow: removal of support, bright lights, loud noises, pain, hunger, thirst, heat, cold. The organism reacts in a successive way until the driving stimulus is removed. The question has been asked, experimentally, of what is the composition or

configuration of the physiological drives. Boring (1915) found that hunger is primarily pressure stimuli, and sometimes pain, localized in the stomach, and that nausea is primarily pressure stimuli, and sometimes pain, localized in the esophagus. Leading experimenters in this field are Boring, Brunswick, Cannon, and Wada.

B. Conscious Motivation

The conscious driving stimuli are known as intents, such as, the intent to act, the intent to learn, and the intent to work. In their earliest manifestations these intents are complex sensitivities, such as the pain of mosquito bites or the heat of a hot day.

C. Social Motivation

The social driving stimuli become more important as the organism develops. These stimuli dominate the life of the adult except in illness and extreme physiological stimulation. They are formed of new relationships of physiological and conscious motivation in which the reactions of people and other animals have taken on significance. Important social driving stimuli follow: prestige, vocational interest, religion, wealth, appearance, competition, cooperation, and so on. Motivation is social under the natural conditions of life.

VI. THE EXPERIMENTAL INVESTIGATION OF MOTIVATION

Experimentation in the field of motivation has proceeded along five lines: (a) the investigation of animal drives, (b) the study of physiological and social drives in humans, (c) the investigation of the conscious intent, (d) the investigation of nerve stimulation and glandular activity, (e) the clinical study of unconscious motives and wishes (psycho-analysis).

A. The Study of Animal Drives

The classical experiment in the study of animal drives was performed by Moss in 1924, in which a ratio of time and electrical resistance was computed as a measure of hunger drive, sex drive, and maternal drive in rats. The strength of these drives was found to be in the relative order given. Two approaches are used in the measurement of animal drives. These are called: (1) the goal method and (2) the drive method.

1. The Goal Method. The effects of changing situations are measured by the goal method. The *goal*, which is an *incentive* known to the animal, is separated from the animal by an obstacle. It is not immediately sensed by the animal, that is, it is a recalled sensitivity. A change in the incentive is made between trials, and the effect of the original goal is measured in the next trial in relation to the new goal. Tolman (1932) used this method in a study of the activity of rats under changing stimulating situations. A maze, through which the rat had to run to reach the goal, was introduced as the obstacle. Standard

physiological conditions of thirst, hunger, etc. (physiological drive) were maintained and food, water, etc., (the goals) were changed. The relative effect of changing 'goals' was measured as speed of maze running. This measure was interpreted as objective evidence of the effect of changing goal-ideas (intents) in the rat.

2. The Drive Method. A measurement of the magnitude, or strength, of the physiological drive is achieved by the drive method. The incentive is held constant. It may be food, water, member of the opposite sex, etc. An obstacle is placed between the animal and the incentive, but the incentive can be sensed by the animal. The obstacle is varied or held standard and the measure of the strength of the drive is the number of 'crossings' of the obstacle. Warden (1926) introduced a high degree of exactness for this measurement in what he called the 'Columbia Obstruction Method'. An animal (usually rat or monkey) for whom the physiological drive can be stated in terms of time without food, water, etc., was placed in the obstruction apparatus. This apparatus contained the incentive beyond the obstacle, which consisted of an electrically charged grill. In these experiments both the electric charge of the obstacle and the conditions of drive were varied. The following comparable average number of 'crossings' in 20 minute tests for white rats were reported by Warden and his associates (1931).

Drive	*Number of Crossings*
Maternal	22.4
Thirst	20.4
Hunger	18.2
Sex	13.8
Exploration	6.0
No Experimental Drive	3.5

These are measures of relative strength of physiological drives and when applied to other animals the measure should offer comparative information of the relative importance of the various physiological stimuli or needs of life.

B. The Study of Drives in Humans

Experimentation on the effect of changing physiological drives in humans involves greater difficulties than with animals. All motivation is social and the social aspects of motivation are particularly evident when the intensity of physiological drives is normal or natural. Humans are seldom submitted to the intensity of physiological motivation often present in experiments with animals. When motivation is 'natural', the social stimuli in the stimulating situation appear to be interrelated in a manner making it difficult to establish standard conditions for experimental work. This is evident in all experiments on the effect of incentives in educational and industrial situations.

An experiment in human motivation usually establishes conditions in which the 'drive' is a usual situation in education or industry, such as regular class work for children in school. The effect of changing incentives (goals), such as a reward of being made a captain of a team, or one of an increase in wages, are measured. Encouragement, discouragement, pain, noise, and rhythm, are other incentives used in such experiments. The effect of changing stimuli (incentives) are compared under standard conditions.

C. The Investigation of Conscious Intent

It was discovered early in the history of psychology (1880) that conscious intent determines the sequence of thinking. Intent is stimulation in awareness. It embodies the social stimuli in the total stimulating situation. A change in environmental stimulation must be represented in intent to affect behavior, and changes in social incentives can best be traced in the development of intent.

D. The Investigation of Nerve Stimulation and Glandular Activity

The study of the energy conditions of nerves and the secretions of glands contribute to the knowledge of motivation. Physiological psychology deals with these dynamogenic effects. The aim of the psychologist is to trace activity through its continuum from the action of environment upon a living organism to the action of the organism upon the environment. The heat, CO_2, and electricity given off under conditions of physiological excitation are measures of motivation, which are as important in understanding this continuum as are the descriptions of thinking.

E. The Clinical Study of Unconscious Motives and Wishes (Psychoanalysis)

The repression of highly motivated activity, primarily of a physiological kind, affects the adjustment of the individual in various ways. Society (environmental social stimulation) causes a change in native reactions. Satisfactory and unsatisfactory adjustments are made through learned reactions. Where there is not a satisfactory release of this motivation, unsocial reactions and abnormal mental activity often result. Much of this psychological activity is unconscious and psychoanalysts study it by the technique of 'analysis.'

VII. ADJUSTMENT

This chapter has enlarged the concept of stimulation to include all causes of the reaction, whether environmental or integrative in nature. Various considerations have led to a dynamic concept of reaction. The early driving stimuli to inherited reactions are physiological

in nature. Later driving stimuli embody social situations. Driving stimuli, and the reactions to them, become more and more complex as development continues.

Adjustment, itself, is a part of stimulating situations. Learning progresses toward an adjustment which is represented in later motivation in the form of a conscious goal. Adjustment of reaction to the environment offers the criteria for the development of intent to improve adjustment.

Part B

NATURAL PSYCHOLOGICAL ACTIVITY

The application of the experimental method to the problem of mind is the great outstanding event in the history of the study of mind . . . .

—E. G. Boring, in
A History of Experimental Psychology

The experimenter in psychology is concerned with the investigation of natural activity. His primary interest is in the normal or natural psychological existences of life, either individually considered or as averages of groups. Part A has dealt largely with the units, or elements of psychological activity, such as a pattern reaction, a sensitivity, and a driving stimulus. These are psychological abstractions which result from generalizations. They do not exist independently in natural activity. In Part B, stimulus and reaction, and the integrative connections existing between them (S-I-R activity), are studied as they are found in natural psychological activity.

The following chapters are included in Part B:

Chapter V, "Social Motivation," logically follows Chapter IV as a more detailed analysis of mass stimulation. This discussion is primarily on the human level where differing motivating effects are evident under the same environmental conditions. Intelligence is the capacity to learn and its measurement has become an important field of psychological investigation. The nature and measurement of intelligence (capacity) is discussed in Chapter VI. A better adjustment to environment is a measure of integration. From the point of view of improvement of adjustive reactions, this process is called learning. It is discussed in Chapter VII. Disintegrative activity, called "Emotion," is studied in Chapter VIII. Individual differences are evident the moment one begins to measure and they are considered in both Chapters VI and IX. The relative influences of motivation, intelligence, learning, and emotion are evident in the adjustment of the organism to its environment. This total adjustment is called 'Personality' and it is considered in normal and deviate aspects (Chapter IX).

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Chapter V

SOCIAL MOTIVATION

Mass Stimulation and the Total Situation

Motivation under the natural conditions of human life is always social in implication. Recent experimental work in the field of animal psychology suggests a similar conclusion for infra-humans. Investigations enumerated in the previous chapter lead to the conclusion that under natural conditions, such as in learning or emotional activity, the important causative factors are the social implications embodied in mass stimulation. When the structure of mass stimulation is described and measured it is called the total situation.

I. SOCIAL MOTIVATION PATTERNS

Certain complex patterns of stimulation, and of reaction, are considered to be the field of social psychology.

A. Classification of Stimulus Patterns

Allport (1924) distinguishes two types of aggregations or social integrations, the group and the crowd. The group is an aggregate of two or more persons deliberately acting together in some way and the crowd is distinguished from the group by the presence of emotional excitement and motivation on a more primitive level. Mass stimulus patterns of social activities are classified, according to Allport, into (1) *social facilitation* and (2) *rivalry*. 'Social facilitation' is motivation due merely to the presence of others. Rivalry is motivation with the goal of superiority in achievement. Rivalry takes the form of (a) *group rivalry*, which has as its goal the superior achievement of a group or team, and (b) *individual rivalry*, which has as a goal the superior achievement of the individual.

B. Experimental Investigation of Social Facilitation

Social facilitation has been found experimentally to be an important factor for the motivation of achievement.

1. With Children. Mayer (1903) showed that school boys do more work when working as a group than alone and Schmidt (1904) showed that children do better work in school than when alone at home. These are the classical investigations of social facilitation. Meumann (1914) found a similar situation to exist in experiments with children upon rote memory.

2. With Adults. Allport (1920) showed that free associations of adults when working in groups were 65 to 93 percent more numerous than when working alone. Social facilitation was greater during the first part of the work, and the stimulation was greater in mechanical than in abstract tasks.

3. With Special Groups. Social facilitation is normally present where people are working in groups. But the group may have an opposite stimulating effect under special conditions. Travis (1925) found that stutterers accomplished more in writing free associations when working alone than they did when working in groups.

C. Experimental Investigation of Rivalry

In rivalry, the stimulating situation is highly complex, with many variables present in the motivation. Triplett first subjected this situation to experimentation in 1897 and came to the conclusion that there was a definite *dynamogenic effect* of pace-making by a second person.

1. The Rivalry Situation, Particularly Among Children. It has been shown by numerous investigators that rivalry will increase accomplishment in mental work by adults or children by 50 per cent or more. Leuba (1930) found, among school children, an increase in accomplishment of 47 per cent with group rivalry, 52 per cent with rivalry for a candy reward and 65 per cent with both, thus indicating the complexity of motivation in rivalry. Group rivalry stimulation is not as great for the superior performers in a group as it is for the inferior (Moede, 1914). Leuba showed that in a rivalry situation the highest quarter of the group of children increased only 34 per cent against an increase for the lowest quarter of 71 per cent. The motivation of the older children in a group is not as great as it is of the younger children; nor is it of superior children as it is of inferior children of the same age; nor of boys as it is of girls in the same group (Hurlock, 1927). Much that has been said about children applies to adults. Rivalry motivation is highly complex and individual in its effect.

2. Special Rivalry Situations. Special rivalry situations have been found to have certain different effects. Wittemore (1924) showed that individual rivalry was a stronger stimulating situation among hand printers than was group rivalry (cooperation with others to beat another group). Maller (1929) found this to be distinctly true among school children, and further, that the motivation of group rivalry was less persistent than individual rivalry.

II. THE PHENOMENA OF MOTIVATION

The 'mass' stimulating situation may be broken up for experimental study into 'factors involved.' But the stimulating situation affects the individual as a 'whole,' while individual differences in results may

indicate that the motivation is not the same for different persons or for the same person over any period of time. The 'mass' is dynamic and ever changing in pattern, as different factors in the total complex change in their relations. Specific factors in motivation are studied as 'knowledge of results,' reward, punishment, praise, reproof, distraction, and so on.

A. Knowledge of Results

The effect of *knowledge of results* was first investigated by Judd (1905) in an experiment in which practice without knowledge was found not to change the accuracy of judgment of length of lines. But when there was 'knowledge of results' there was correction and improvement. 'Knowledge of results' is the factor in the stimulating situation informing the individual of social relationships of rivalry and recognition. Book and Norvell (1922) found in a controlled experiment that every man and woman (124 individuals) fell below their best score when 'knowledge of results' was removed. When 'knowledge of results' was added to the learning situation every subject gained over his best record when no 'knowledge of results' was present. Thorndike, and others, report consistent evidence of the motivation effect of 'knowledge of results' for various kinds of both mental and motor behavior. How 'knowledge of results' functions as a part of the total situation is not exactly clear, but it evidently takes its place as a factor in building intent for accomplishment.

B. Punishment

Punishment stimuli, such as intense sounds, lights, and electric shock, were shown early by Cleghorn (1898) to increase muscular contractions in work on an ergograph. Electric shock has been used often as the punishment stimulus in research upon human beings. According to Rexroad (1926) punishment of this kind has various stimulating effects, as follows: (a) instructive, as in 'knowledge of results,' (b) inventive, as in 'insight' or the adoption of new plans of work, and (c) disruptive, which decreases efficiency. The two former conditions are aspects of 'knowledge of results.' Johanson (1922) compared the effect of 'knowledge of results' (called reward) with electric shock (called punishment) in reaction time. In both cases there was a reduction in time of the reaction, with punishment (15%) twice as effective as 'knowledge of results' (6%). Bunch (1928) studied the effect of electric shock as punishment for errors upon learning a human maze and got a decrease of 50 per cent in number of trials and 30 per cent of total amount of time consumed in the learning. According to Vaughn and Diserens (1930) reaction-time decreases as punishment (electric shock) increases in intensity. There is evidently a motivating effect of painful punishment that is greater than punishment that offers 'knowledge of results.'

C. Reward

The effect of food and sex upon reaction (organic motivation) has been thoroughly studied among animals by numerous investigators. Such rewards are always adequate motivating stimuli for increased speed or efficiency of reaction. Pavlov and his associates have used food rewards as the adequate stimulus in the study of conditioned reflexes among both animals and humans. Often 'reward,' as with 'punishment,' is not distinguished from 'knowledge of results' in experiments. Such motivation factors may be called 'success' or 'effect' stimuli, and they materially speed up learning or efficiency of reaction as shown by Thorndike and others. Chase (1932) found that 'knowledge of success' increased efficiency of performance upon a modified *dynamometer*, but that a gold star (reward) in addition to this stimulus only slightly increased the motivation. As already indicated, Leuba showed an increase in achievement of 52 per cent with a chocolate bar as a reward, while with rivalry alone it was 47 percent, and food reward and rivalry together, 65 per cent. So the motivating effect of reward alone, or with rivalry controlled, was 18 per cent.

D. Reward and Punishment Compared

Educators have wanted to know which is the stronger motivating factor in learning, reward or punishment. The popular theory today bases training upon reward motivation.

1. Among Animals. The investigation of these factors as motivating stimuli began in animal psychology and, as early as 1907, Yerkes showed that punishment (an electric shock) was the more effective stimulus with the dancing mouse. It was further shown that different strengths of the electric shock had relative beneficial effects upon the learning in proportion to its difficulty. These conclusions have been verified by a number of investigators. Hoge and Stocking (1912), contributed the evidence that a combination of food (reward) and electric shock (punishment) was the most effective stimulus for learning among rats. Warden and Aylesworth (1927) verified this conclusion and again showed that punishment was the more effective single stimulus.

2. Among Humans. Among humans the reward-punishment situation seems to be far more complex than it is with animals. Hamilton (1928) is the only investigator attempting to equate the two by ringing a bell, at times for failure and at other times for success, to indicate accuracy of discriminations on the *Galton Bar*. Here again, the stimulation is definitely 'knowledge of result' and, as would be expected, they were equal in their motivating effect (exactly 24 and 26 percent increases).

It seems impossible to compare punishment and reward as motivating stimuli among humans. Both are effective under various conditions and both have conscious and social implications. Among animals very painful punishment is found to be more effective than any known reward. It would seem that this should be true among humans, but punishment under these conditions is more than social approval and rivalry. It is a change in the physical environment to be avoided by the person.

E. Praise and Reproof

Praise and reproof are found to have specific motivating effects. The initial effect upon accomplishment of either praise or reproof is about the same. Chase (1932) found reproof to be in ascendency over praise with young children and Gilchrist (1916) found praise to be superior. Gates and Rissland (1923) found praise to be in ascendency as a motivating stimulus for motor coordinations and reproof for color naming. Hurlock's (1925) investigations are the most extensive upon this subject, and praise is found to be the stronger motivating stimulus both in its initial effect and especially over a long period of time. The stimulating situation of 'praise,' which is a social reward among humans, would seem to be superior to reproof and educators have accepted this conclusion as the basis of a philosophy of education.

III. 'NON-SOCIAL' MOTIVATION

Certain stimuli, such as electric shock and noise, are often treated as non-social in their motivating effect. That their effect is not always the same in different situations is a conclusion of many experiments among both animals and humans. The causative factor of this difference would seem to be the social implications of the mass stimulation. It is necessary to consider all specific stimuli as having social motivating effects.

A. Noise and Distraction

Noise abatement commissions exist in numerous cities all over the world and rules have been established for the regulation of noise. Undoubtedly, the number of unpleasant stimuli is reduced by such measures. But it is doubtful if there are the deleterious effects usually attributed to excessive noise stimulation. The experimental evidence points only to the conclusion that noise is unpleasant (disliked).

B. The Experimental Investigation of Noise and Distraction

Early, Morgan (1916) showed that there was a slight decrease in speed of mental work at the beginning of a period of noise, followed by an increase. The new rate was sometimes greater than that before the introduction of noise. Extra effort was put forth during the noise

stimulation and various methods, such as articulation of mental work, were used to eliminate what the worker regarded as distractions. These results have been verified by several experimenters. There may be definite increases in accomplishment due to distraction stimuli in the total situation. Physiological effects are slight or unmeasurable (Harmon, 1933). Pollock and Bartlett (1932) offer a theory of adaptation as an explanation of what takes place under noise stimulation. Noise and distraction are said to add new conditions to the stimulating situation, and intent is again related under these conditions to the original goal of work. All experiments agree that noise tends to produce a slight and readily recoverable loss in efficiency followed by individual increases which are related to the development of conscious intent. But it is evident that noise, even to a high degree of intensity, has little deleterious effect upon efficiency in mental work.

IV. THE CONSCIOUS INTENT IN THE MOTIVATION OF BEHAVIOR

The driving stimulus or stimulating situation in awareness is called the *intent* or *Aufgabe*, which is the awareness of *goal* and *plan* of the activity. Intent is causative of most psychological activity, although automatic reactions, such as walking, once set in motion, are continued under the stimulation of the activity itself ('activity in progress' of Woodworth). The intent is the pattern of conscious stimulation in any unit of psychological activity.

The pattern of intent changes and develops in awareness. The observer may report awareness of numerous environmental changes (sensitivities) without their being related to the previously established intent in the performance of a task. But as he is aware of environmental changes, such as the awareness of distraction stimuli or of 'knowledge of results,' certain sensitivities may be followed by a sequence of psychological events of which they are causative. Such sensitivities are related to the existing goal and plan of work.

Any awareness may be an intentional awareness causing later conscious events. In a series of conscious events any awareness may be causative in greater or lesser degree according to 'acceptance' in relation to the intent of the moment. The 'acceptance' is determined largely by the previous intent or mental set and this 'acceptance' may cause a complete change in activity and the development of a relatively new intent.

The difference between intent and mental set is purely one of degree. Intent has clear dimensions or conscious details of goal and plan of work; *mental set* or *Einstellung* does not, but the observer may report a vague awareness of what he is doing. But even though the

observer is not aware of either goal or plan of work, or the 'why' of his performance, the mental set continues to direct the 'activity in progress.' Where causation is of a sequence of events the driving stimulus has been called a *determining tendency* (Ach).

Mental set is sometimes referred to as *motor set,* because causation of the activity seems largely in the habitual sets of the motor performance, as with the tennis player making a quick smash, or the punting of the football player. Automatic activity, with its specific reflexes, and autonomic activity in the vegetative processes of the organism is likewise spoken of as directed by motor set.

V. MASS STIMULATION (THE TOTAL SITUATION)

The early initiating causes of psychological activity are environmental stimuli, and in particular, implicit stimuli such as hunger pressures acting upon interoceptors. But very early these fundamental physiological drives are conditioned to explicit environmental stimuli and take on social significance. The specific stimuli act together as a mass and the total situation involves awareness. Environmental stimulation can affect reaction only as there is integration of stimulation, and this takes place in awareness in the form of intent to act. It is in awareness that the social implications of specific stimuli become apparent.

Specific factors in motivation, such as praise, reward, 'knowledge of results,' and distraction are studied by objective methods and measurements can be made of them in terms of amounts of stimulus and accomplishment. The pattern of this stimulation is observed in awareness where the integration of mass motivation takes place. The significant conclusions from the observation of motivation are: (1) that the effect of stimulation upon reaction is total rather than specific. Each specific factor, like reward, is influenced by all other factors in the mass stimulation. (2) Causative of the integration of mass stimulation are its social implications. (3) The causes of psychological activity are essentially conscious in the form of intent.

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Chapter VI

INTELLIGENCE

Its Measurement in Relation to Adjustment

The adequacy of reactions, as adjustments to environmental stimulation, varies greatly from individual to individual. Some persons consistently make better adjustive reactions than do others. Adjustive capacity is studied by the psychologist as intelligence and is measured by tests.

I. DEFINITION OF INTELLIGENCE

Authors and experimenters have defined intelligence in various terms, which seem to vary widely in general meaning. Such definitions are given as: (1) Intelligence is the ability to think in abstract terms (Terman); (2) It is the ability to learn to adjust oneself to his environment (Colvin); (3) It is a capacity to acquire (Woodrow); (4) It is a general ability to consciously adjust thinking to meet new requirements (Stern); (5) It is a biological mechanism for integrating stimuli and producing adequate and unified responses (Peterson).

A. What Intelligence Is

While differences are apparent in the definitions given, they are all in agreement on certain points: (1) Intelligence is a capacity for acting, and is not a mechanism for established reactions; (2) It is an inherited or native capacity; (3) It is unaffected by *nurture*, but *nurture* may limit the opportunities for expression of the capacity; (4) The capacity grows or matures with age during childhood and adolescence; (5) On the average, the capacity is mature sometime between the fourteenth and sixteenth years of life.

B. What Intelligence Is Not

Intelligence is not the same as knowledge. But the amount of knowledge accumulated is limited by intelligence. Intelligence is not the same as talent. Talent implies both native capacity and practised skill along some special line of activity, as in music, art, and writing. Intelligence is not the same as memory. Persons of low intelligence frequently have good memories. Intelligence is not the same as skill. Skills are acquired through practice. Intelligence is not adjustment, but it is a capacity for the development of adjustive reactions.

C. Intelligence and Personality

The measurement of psychological activity has developed along two distinct lines called the measurement of personality and the measurement of intelligence. Personality is truly all of psychological activity when measured, but a distinction is made for practical purposes. Intelligence measures, which are discussed in this chapter, are measures of efficiency of reaction from which capacity (intelligence) is interpreted. Personality measures test activities such as emotion, feeling, motivation, attitude, interest, and so on. These psychological activities influence the efficiency of reaction, of course, but personality measurement is not made for the purposes of indicating intelligence. It is made in order to understand a specific quality (trait) in personality. Personality measurement will be discussed in a later chapter (Chapter IX, Personality and Adjustment).

II. THEORIES OF THE NATURE OF INTELLIGENCE (CAPACITY)

Numerous experimental and statistical studies have been pursued for the purpose of understanding the nature of intelligence (capacity). Some of these have been concerned with the neuro-physiological basis and others with the conscious and behavior aspects of the capacity.

A. Neuro-physiological Theories

Neuro-physiological theories of intelligence are closely related to theories of learning. Although the learning process is one of achievement or acquisition, learning would be impossible without intelligence. Intelligence is the capacity for learning.

1. General Physiological Theory. Intelligence, like learning, is related to the changing resistance of the synapses between neurons of the nervous system, and to the complexity of that system. Some authorities relate intelligence to the size of the brain, especially the cerebrum. This is particularly true when comparisons are made of the intelligence of various species of animals. Some writers relate intelligence to metabolism of the nervous system and to the blood supply to the brain.

2. Holt's Theory of Neuro-biotaxis (1931). Intelligence, like learning, is a function of neuro-biotaxis, which is the capacity for development of dendrite-axon contacts through the growth of dendrites, and also through the growth of axons. Neuro-biotactic growth is said to be the activity reducing the resistance at the synapse. (Learning is neuro-biotactic activity.)

B. Conscious and Behavior Theories

Other theories of the nature of intelligence have arisen from measurement and the statistical treatment of test results. Among these theories are the following:

1. General Capacity Theory (Stern, 1910). Intelligence is a general capacity (G) which may be directed in any field of activity. According to this view any individual has equal capacity for reaction in any field. The special field of reaction in which he will attain proficiency depends on the environment.

2. The Two-Factor Theory (Spearman, 1901). Intelligence is composed of a general capacity (G) and specific capacities (S_1, S_2, S_3, etc.) for expression in various fields of reaction such as music, skating, and mathematics.

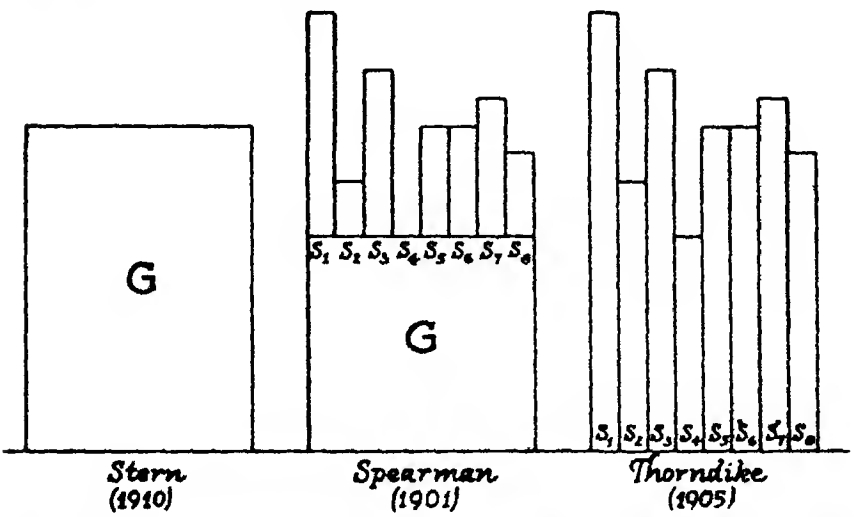

Fig. 7. A schematic comparison of three leading theories of the nature of intelligence. The three figures are equal in area. Stern holds that all intelligence is general (G); Spearman postulates some general intelligence (G) and a number of special capacities (S); according to Thorndike intelligence is a number of special capacities (S). Stern's view allows for individual differences only in the amount of G each possesses. According to Spearman individuals may differ in G with S equal, or they may differ in S with G equal, or they may differ in both G and S. By Thorndike's theory differences could occur only in the amount and distribution of S.

3. Multi-factor Theory (Thorndike, 1905). Intelligence is not a general factor, but is the sum-total of many specific capacities (S_1, S_2, S_3, etc.). Possibly 'general' manifestations of intelligence depend upon unitary fields of environmental stimulation, as follows: (a) Abstract Intelligence, (b) Mechanical Intelligence, (c) Social Intelligence.

4. Behavior Continuum Theory (Thurstone, 1924). Intelligence is a function of the point in behavior where an individual reverts to trial and error. It is the capacity to focalize awareness at early, unfinished stages of formation of any activity.

C. 'Kinds' of Intelligence

Thorndike (1920) indicated three chief 'kinds' of intelligence; abstract, mechanical, and social. The term 'concrete' is perhaps more fitting for mechanical intelligence.

1. Abstract (Verbal, General) Intelligence. By abstract intelligence is meant the capacity to manipulate and deal with symbols, such as language and mathematics.

2. Concrete (Mechanical) Intelligence. Concrete intelligence is the capacity to manipulate and deal with things such as mechanical contrivances, art, and perhaps music.

3. Social Intelligence. Social intelligence refers to the capacity for dealing with people. It includes much of what is popularly called personality. Experiments confirming this division have not been prosecuted.

All three 'kinds' are probably general intelligence expressed in different environmental fields. However, such a classification is convenient for the limitation or definition of unitary environmental fields of investigation.

III. MEASUREMENT BY TESTS

The measurement of adjustment, and capacities for adjustment, is the function of mental tests. Each test *item* (problem, question), is a pattern of stimulation. The variety of possible reactions is limited by the form of the test. Reaction in a prescribed manner is evidence of adjustment to the stimulus and the number of acceptable reactions (the score) is indicative of the degree of adjustment.

Hundreds of tests have been developed as measures of various combinations of reactions (performances, capacities, aptitudes, abilities, traits, intelligence, personality, and achievement). The following list indicates the scope of measurement by tests: anthropometric measures, tests of sensitivity, tests of motor abilities and skills, tests of perception and abstract processes, general intelligence tests, musical, mechanical, and artistic aptitude tests, tests of social intelligence, tests of emotional behavior, measures of character, measures of personality, attitude and interest scales, and tests of educational and vocational abilities. Not all tests are measures of intelligence.

IV. CHARACTERISTICS OF TESTS

Tests have certain general characteristics, some of which follow:

A. Tests are Standardized Experiments

The *scientific investigator* makes use of tests in different ways as materials in an experiment. For measurement purposes, the *scientific tester* always uses tests in a prescribed manner, which has been determined in the construction of the test. Hence, a test is a standardized experiment.

B. Tests Sample Reactions

Test items are so chosen that they are *samples* of a mass of reactions. It is obviously impossible to measure all reactions at one time, or all reactions in any one environmental field. Items of a test sample reactions in a unitary field of the environment.

C. Individual vs. Group Measurement

Tests are arranged for individual and group administration and are called *group tests* and *individual examinations*.

D. Verbal vs. Non-Verbal Tests

Testing materials are prepared so that measurement is either of language or motor reaction. Tests are classified into (a) verbal (language) tests and (b) non-verbal (non-language) tests. Most tests, both individual and group, require knowledge of language. Directions are given verbally, either orally or written, and *S* (subject) is required to react verbally. Directions for non-verbal tests are given in pantomime, or by examples, and S reacts by marking on pictures or by the manipulation of objects.

E. Speed vs. Power Tests

Tests are classified as speed or power tests. Speed tests have standard time conditions. All items are of equal difficulty and the score is the number of items correctly answered in the standard time. In the power test there is no time limit and the score is the number of items correctly answered. The items are scaled for difficulty, that is, the easiest item comes first, and each succeeding item is more difficult than the one it follows. Many tests are combinations of speed and power tests.

F. Speed-accuracy Distinction in Tests

Tests differ in their emphasis on speed and accuracy. Those tests emphasizing accuracy include problems in which time is not a factor in the measurement.

G. Performance vs. Capacity for Performance

All tests are measures of reactions; they are measures of performance. But performance may be measured at various stages of specialization. Capacity for performance (intelligence) is inferred from measurement with tests requiring a low degree of specialization of reactions. Prediction of performance in specialized fields is made from intelligence tests. Persons who score high in intelligence tests are assumed to have the capacity to score high in any specialized performance (achievement) test if given equal training with others in the field of specialization.

This is a fundamental inference in psychology, and it is verifiable experimentally. The distinction leads to a classification of tests as *achievement tests* (accomplishment) and *capacity tests* (intelligence, aptitude). The term 'aptitude' is used to refer to special capacities, or capacity in a limited field of reaction.

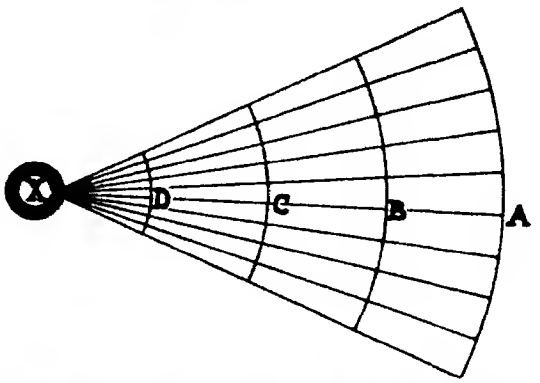

Fig. 8. *Capacity and Performance in Measurement.* Capacity (X) is analogous to a vacuum; it can be measured only in its expression. The lines extending outward from (X) indicate the development of specificity of reactions. At D specialization is not as great as at C, B, or A; but the reactions can be measured at any point between (X) and A. Measurement of performance at A, where there is a high degree of specialization, is called achievement measurement. Measurement at B, C, or D are more general and are more representative of capacity. However, all tests measure reactions and capacity is inferred, just as the vacuum is inferred from measurements of its effects.

H. Test Batteries and Scales

A group of tests measuring different performances (or interpreted capacities) are often assembled together to give a general or composite measure of a unit of behavior. These groups of tests may be large or small, according to the extent of like reactions being measured. Such groups of tests are called *test batteries* or *scales*. When the tests of a battery are assembled in age levels it is called an *age scale*.

V. TESTS OF GENERAL (ABSTRACT) INTELLIGENCE

The form of the battery of tests, which is called a general intelligence test, depends on the way in which it is used. The administration of the test may be individual or group, verbal or non-verbal, or for speed and power measurement. The items of general intelligence tests are selected so that (1) individuals of any prescribed social group will have equal opportunity for familiarity with the problem presented, and (2) reactions to the items will not depend on formal education (schooling). Capacity is inferred from performance on these tests.

A. Individual, Verbal, Power Tests

In 1905 Binet and Simon formulated and used the first battery of tests of general intelligence. This battery was composed of 32 single tests designed to measure memory, mental imagery, imagination, attention, comprehension, esthetic feeling or appreciation, moral sentiments, and judgment, all of which taken together indicated general intelligence. A revision of the 1905 battery by Binet and Simon appeared in 1908 as the first age scale and a second revision appeared in 1911. Huey (1910) and Goddard (1911) translated the Binet-Simon scale into English. Goddard revised the scale slightly and used it in the Vineland Training School. These translations were followed by many other American revisions, the most important of which follow:

(1)	Kuhlmann	1912
(2)	Yerkes, Bridges, and Hardwick	1915
(3)	Stanford Revision (by Terman)	1916
(4)	Kuhlmann	1922
(5)	Herring	1922
(6)	Yerkes and Foster	1923
(7)	Stanford Revision (by Terman)	1937

Of these scales, the Stanford Revision (1916) has been most widely used. It is composed of 90 items ranging in age placement from 3 years to 18 years. Problems, such as, pointing to parts of the body, following simple directions, esthetic discriminations, visual discrimination of forms, counting, items of judgment and comprehension, naming colors, and repetition of syllables and numbers, are included in the tests for years 3, 4, 5. Problems of fact, arithmetical reasoning, visual imagery, induction, vocabulary, interpretation of fables, definition of abstract terms, repetition of digits, repetition of digits in reverse order, repetition of the thought of a prose passage, and reasoning, are included in the tests for years 14, 16, and 18. The Kuhlmann Revision extends the age range of the scale downward to three months. It is more difficult to administer than the Stanford Revision. The Herring Revision is most easily administered and requires fewer materials than do the other revisions.

B. Individual, Non-verbal, Power Tests. (Performance Scales, Non-language Tests).

Tests involving knowledge of language would obviously be unfitted for use with foreign speaking, illiterate, or very young subjects. Non-verbal tests (also called performance tests) are used to test such persons; also, they are used as a check on verbal tests. These tests involve the manipulation of objects such as fitting blocks into appropriate recesses in boards (form boards), solving manipulative puzzles, and so on.

1. Single Tests. Single non-verbal tests have an important place in mental measurement because they offer a rapid approximation of capacities under conditions where exact testing is difficult. A few outstanding single non-verbal tests will be described here.

a. *Seguin Form Board.* This is a board in which certain geometrical figures have been cut (the figures include a star, cross, circle, triangle, diamond, square, etc.). S is required to place blocks, fitting these figures, in the appropriate recesses. There are many revisions of this test by Goddard, Witmer, Sylvester, Pintner and Paterson, and others. Similar form boards have been devised by Dearborn, Ferguson, Kent and Shakow, and others. The test is arranged for greater difficulty (for various age levels) by cutting the blocks into two or more pieces.

b. *Healy Pictorial Completion Tests.* In these tests, incomplete pictures are presented to S. He is required to select the best of a number of pieces and complete the picture. The Knox Ship Test, The Mare and Foal Test, and many others, follow this procedure.

c. *The Manikin and Feature Profile Tests.* These are small human figures cut into pieces of varying shapes which are to be assembled by S.

d. *Kohs Block Design Test.* A number of many colored cubes are used by S to construct replicas of designs painted on cards.

e. *Knox Cube Test.* The examiner taps on blocks in a certain sequence and S repeats the sequence as he remembers it.

f. *Porteus Maze Tests.* A series of paper and pencil mazes has been developed for the non-verbal measurement of intelligence. The mazes may be used separately as a measure of intelligence at a certain level, or in serial order as an age scale.

2. Non-verbal Batteries. Groups of form boards and other non-verbal tests are assembled into batteries. Healy and Fernald (1911) and Knox (1914) prepared non-verbal batteries of tests, but the earliest general intelligence battery, sampling non-verbal reactions, was the Army Performance Scale (1917), which was developed by the psychologists in the Army during the World War. This battery included ten tests, as follows: The Knox Ship Test, the Manikin and Feature Profile Tests, the Knox Cube Tests, the Goddard Cube Construction Tests, the Dearborn Form Board, Terman's Memory from Designs Tests, the Digit-Symbol Substitution Tests, The Porteus Mazes, a Picture Arrangement Test, and the Healy Pictorial Completion Tests.

The most widely used performance scales today are the Pintner-Paterson Performance Scale (1917), and the Arthur Point Scale of Performance Tests (1928). For measurement of young children, the Gesell Scale (1925) and the Merrill-Palmer Scale (1931) are extensively

used. The Pintner-Paterson Scale consists of seven form boards, the Manikin Test, the Feature Profile Test, the Ship Test, two Picture Completion tests, a Digit-Symbol Substitution Test, Goddard's Adaptation Board, and the Knox Cube Test.

C. Verbal Group Tests

Individual tests are limited in their use, because one examiner is required for each subject to be tested. Group tests were developed by Otis and others about 1914 to overcome this difficulty. These tests usually combine the speed and power factor in measurement.

Group Examination Alpha (1917), which was devised by the psychologists in the U.S. Army, is the earliest and best known battery of verbal group tests. It is composed of 212 items in eight sub-tests as follows: Test 1. Following directions, Test 2. Arithmetical computation and reasoning, Test 3. Common sense, Test 4. Sameness and opposite-ness of pairs of words, Test 5. Scrambled sentences, Test 6. Arithmetical completion, Test 7. Word relationships, Test 8. Information. Several revisions of Army Alpha have been prepared, and practically all other verbal group tests, of which there are several hundred, are patterned after this test. Among the verbal group tests most widely used today (in addition to Army Alpha) are: The Terman Group Test (1920), The National Intelligence Tests (1920), The Otis Group Tests, of which there are several forms for different uses and different age levels (1919), The Kuhlmann-Anderson Tests (1927), and The Henmon-Nelson Tests (1932).

D. Non-Language (non-verbal) Group Tests

As with the individual non-verbal tests, the non-language group tests are designed for illiterates, children, and others not possessing adequate language facilities. Several non-language tests were assembled by Army psychologists to form a battery known as Group Examination Beta (1917). The Army Beta is composed of seven sub-tests as follows: Test 1. Maze tests, Test 2. Cube analysis, Test 3. Letter arrangement series (V-O), Test 4. Digit symbol substitution, Test 5. Number checking, Test 6. Pictorial completion, Test 7. Geometrical constructions. Other non-language group tests used at the present time include The Pintner Non-language Tests, Myers Mental Measure, Haggerty-Delta I, The Porteus Mazes, The International Group Test (Dodd and Brigham), and The Michigan Non-verbal Series (Greene). Practically all group tests for the pre-school and primary school levels are non-verbal tests.

E. Tests for Exceptional Persons

Tests of intelligence have been developed for exceptional groups, such as the blind and the deaf.

1. The Blind. Irwin (1915) adapted The Goddard Revision of the Binet-Simon Test for testing the blind. Other important intelligence tests for the blind are Hays' (1930) adaptation of The Stanford Revision and Sargent's (1931) adaptation of The Otis Classification Test.

2. The Deaf. Any non-language performance test may be used without change in the measurement of intelligence of the deaf.

3. Other Special Groups. Special tests have been constructed for measuring the intelligence of: (1) children having sensory defects (Bappert 1922), (2) illiterates (Doll 1926), (3) delinquents (Fernald 1912, Heuyer 1927, Healy and Bronner 1911), (4) feeble-minded and backward children (Goddard 1911, Huey 1912), (5) the mentally disturbed (White 1910, Hart and Spearman 1914, Babcock 1931).

VI. INTELLIGENCE TESTS FOR SCHOOL USE

(Educational Aptitude)

Intelligence tests have been widely used as measures of capacity for success in school. Hundreds of tests have been prepared for this purpose. Tests are available for measurement at all levels from the kindergarten to professional schools.

A. Tests for Grades I to VIII

Tests used for kindergarten and first grade children are generally non-verbal group tests such as The Cole-Vincent Scale for School Entrants, The Pintner-Cunningham Primary Mental Test (1923), The Detroit Primary Tests (1924), The Pressey Primary Tests (1922), and The Kuhlmann-Anderson Intelligence Tests (1927). These tests are composed of pictures (in some cases letters and words) and the children mark the picture according to directions read by the examiner. The Pintner-Cunningham Primary Mental Test is composed of seven tests as follows: common observation, esthetic differences, associated objects, discrimination of size, picture parts, picture completion, and dot drawing. The Cleveland Kindergarten Classification Test is prepared for use at this level as an individual examination patterned after the Binet-Simon and performance tests.

The tests used in the higher grades of the elementary school (grades IV to VIII) are usually verbal group tests patterned after the Army Alpha. Illustrative of the tests for this level of intelligence are the Detroit Alpha (1924), Haggerty Delta 2 (1923), McCall Multi-Mental Scale (1925), The National Intelligence Tests (1920), The Henmon-Nelson Test of Mental Ability for Grades VII and VIII (1932), and The Kuhlmann-Anderson Intelligence Test (1927). Non-verbal material is occasionally used in these tests.

The Kuhlmann-Anderson Test is arranged as an age scale and can be used for all grades and ages from age 4 to maturity. It may be used as a group test or as an individual examination and is composed of 39 sub-tests including both verbal and non-verbal material.

B. Tests for High Schools and Colleges

Measures of educational capacity for high schools and colleges are combinations of intelligence tests and tests of educational accomplishment. They are verbal, group, speed tests and are used for sectioning classes and as college entrance examinations for selective admissions. They are patterned after the Army Alpha examination and leading tests for this level are the Terman Group Test (1920), The Henmon-Nelson Test of Mental Ability (1932), The Otis Self-Administering Test of Mental Ability (1922), The Thorndike Intelligence Examination for High School Graduates (1920), The American Council on Education Psychological Examination (1919 and following; also called the Thurstone Psychological Examination), and The Thorndike C.A.V.D. Examinations (1927). The C.A.V.D. Examinations are tests of sentence completion, arithmetic, vocabulary, and directions. In addition to the tests named above many colleges have developed tests to fit their own special requirements.

C. Tests for Professional Schools

Many professional schools (medical schools, law schools, teachers colleges, etc.) use tests for the selection of students. In most professional schools one or more of the tests for the high school and college level are used. Special tests, such as The Medical Aptitude Test (Moss), The Stanford Educational Aptitude Test (Jensen), The Juristic Aptitude Test (Roback), and the Journalistic Aptitude Test (Moss), have been devised, but except for the Medical Aptitude Test, they have not had wide use.

VII. APTITUDE TESTS: MEASURES OF CONCRETE (MECHANICAL) INTELLIGENCE

Tests for the measurement of specific capacities, such as music, mechanics, and art, are called *aptitude tests*. Aptitude tests are prepared as individual or group examinations; they are composed of either verbal or non-language materials; and they are administered as both speed and power tests.

A. Tests of Musical Aptitude

The most important contribution to the measurement of 'musical talent' is the battery of tests devised by C. E. Seashore (1919), in which he divided general musical aptitude into six specific capacities, namely: discrimination of pitch, discrimination of intensity, discrimination of

time, appreciation of consonance, tonal memory, and memory of rhythm. The tests are administered by phonograph records. The pitch discrimination test is illustrative: two tones are played and S reacts by indicating whether the second tone is higher or lower than the first. The scores on the six tests are plotted as a *musical profile*. The Kwalwasser-Dykema Battery (1927) consists of ten tests similar to the Seashore Series. Persons scoring high on these scales have 'musical talent.'

Other tests of musical aptitude have been devised by Hillbrand (1923), Hutchinson and Pressey (1924), Kwalwasser and Ruch (1924), Kwalwasser (1927). These are all 'paper and pencil tests.' Hillbrand's test measures sight-singing ability, while the others are tests of musical accomplishment or musical information.

B. Tests of Concrete (Mechanical) Intelligence

'Mechanical talent' is measured as a unitary aptitude or a group of relatively independent capacities. It is comparable to general abstract intelligence and may be thought of as general concrete (mechanical) intelligence.

1. Mechanical Aptitude Tests. The first tests of mechanical aptitude were devised by Stenquist and used in the U. S. Army in 1917-18. The tests are of two kinds, namely: assembly tests and paper and pencil tests.

a. *The Assembly Tests.* Stenquist's Assembly Tests consist of a number of small objects, such as a bicycle bell, a door lock, a mechanical pencil, and a paper clip. These objects are taken apart and S is required to assemble them under standard time limits. Toops (1923) devised an Assembly Test for Girls, which included the stringing of beads, lacing cards together, and similar manipulative tasks. The Minnesota Spatial Relations Test (1930) is a form board into which S fits variously shaped blocks.

b. *Paper and Pencil Tests.* There are many tests using picture comparisons and picture completions (Stenquist, 1923; O'Rourke, 1926; MacQuarrie, 1927; Baker and Crockett, 1929) for the measurement of mechanical aptitude. The multiple choice revision of the Minnesota Paper Form Board (Likert and Quasha, 1934) consists of a series of problems of geometrical and spatial relations.

2. Mechanical Aptitude Batteries. Mechanical aptitude batteries (of general concrete intelligence) are prepared in a manner similar to batteries of general abstract intelligence. The Minnesota Mechanical Ability Series (Paterson, Toops, Anderson, Elliott, and Heidbreder, 1930) is such a battery of tests, which is based on the assumption that mechanical aptitude is a group of relatively independent capacities. This battery consists of six tests: (1) a revision of the Stenquist Assembly Test, (2) packing blocks into a small box, (3) sorting cards,

(4) a series of spatial perception form boards, (5) a paper and pencil test of spatial relations, (6) an inventory designed to measure the mechanical interests of the subject. Persons scoring high on this battery have 'mechanical talent' or concrete (mechanical) intelligence.

C. Tests of Artistic Aptitude

The measurement of artistic aptitude has received but little attention. Of the tests developed, the Lewerenz Test of Fundamental Abilities of Visual Art (1927), the Meier-Seashore Art Judgment Test (1929), and the McAdory Art Test (1929) are most important. All of these divide artistic aptitude into several capacities as in the Lewerenz Test which is composed of nine sub-tests: (1) recognition of proportion, (2) originality of line drawing, (3) observation of light and shade, (4) knowledge of subject-matter vocabulary, (5) visual memory of proportion, (6) analysis of problems of cylindrical perspective, (7) analysis of problems in parallel perspective, (8) analysis of problems in angular perspective, (9) recognition of color. An *artistic profile* of the nine capacities is drawn and persons standing high have 'artistic talent.'

VIII. SOCIAL INTELLIGENCE TESTS

The measurement of general social intelligence has received but little attention. Moss, Hunt, and Omwake (1925) devised the George Washington University Test of Social Intelligence. It is designed for use with adolescents and adults and is composed of five sub-tests: judgment in social situations, recognition of the mental state of a speaker, observation of behavior, memory for names and faces, and sense of humor. Scores on this test are found to be related to: (1) sociability and social activities of college students, (2) ratings for social adaptability, (3) ratings of salespeople (Hunt).

IX. TEST SCORES AND NORMS

Test scores are expressed as 'points' or as 'ages.'

A. Point Scores

A point score is the total number of items correctly answered. The point score is varied sometimes as in scoring true-false tests by subtracting the number of 'wrongs' from the number of 'rights.'

B. Mental Age (M.A.)

In revisions of the Binet-Simon Examination, and some other tests, the problems are arranged by ages. These are called age scales and the first age scale was devised by Binet and Simon in 1908. The score is the age at which one answers the problems correctly. Each problem is equal to a certain number of months. A score on the Stanford-Binet

Examination might be expressed as 5 years 2 months, indicating that the child's performance on this test is equal to the average performance of other children 5 years and 2 months of age. Such a score is called the *mental age*. The M. A. is a statement of mental maturity.

C. Intelligence Quotient (I.Q.)

The ratio of the M. A. to the life age or chronological age (C.A.) is called the intelligence quotient (I.Q.), which was first suggested by Stern in 1912. It is a statement of relative brightness. The I.Q. is obtained by dividing the M.A. by the C.A. and multiplying by 100 to remove decimals. Thus a child who was born on March 1, 1929, and scored 6 years mental age on the Stanford-Binet Test on March 1, 1935, would have an I.Q. of 100. His mental age and life age are equal. On the other hand a child of 6, who scored 10 years mental age, has an I.Q. of 166. His mental maturity is far ahead of his life age. Another child of 6, who scored 4 years mental age, has an I.Q. of 66 His mental maturity is far behind his actual life age. In general, I.Q.'s between 90 and 110 are usual and indicate average intelligence. I.Q.'s above 110 indicate mental acceleration or superior intelligence, and I.Q.'s below 90 indicate mental retardation or inferior intelligence.

D. Norms

Norms are standard scores of normal or average development. The norms for an age scale are the mental ages for the standard problems of each age. Point scores must be interpreted by reference to norms.

1. Percentile Norms (%iles). A score of 168 points on the Army Alpha has little meaning until one knows that it is exceeded by only 35 percent of college sophomores. When scores are expressed in percents of those exceeding each score they are called *percentile norms* (*%iles*). There follows a table of percentiles for scores by high school graduates on the Otis Self-Administering Test of Mental Ability, which illustrates the use of percentile norms.

Otis S-A Score	*Percentile*	
67	90	(exceeded by 10% of high school graduates)
60	75	(" " 25% " " " ")
54	50	(" " 50% " " " ")
46	25	(" " 75% " " " ")
40	10	(" " 90% " " " ")

2. Grade Norms. In the same way, a score of 41 points on the Pintner-Cunningham Primary Mental Test has value only when one knows that it is the average score for children in the second grade in school and that scores of 30 and 46 are the averages for the first and third grades respectively. Average scores for various grades are called *grade norms.*

3. Age Norms. Similarly, average scores for various ages are called *age norms*. The 'mental age' is an age norm.

X. RELIABILITY AND VALIDITY OF TESTS

Two essential criteria of a test are: (1) it must measure what it is claimed to measure (*validity*) and (2) it must measure consistently (*reliability*).

A. Validity

The extent to which a test yields a true measure of the performance it is supposed to measure is called the *validity* of the test. For example, a test developed to measure educability at the college level is valid if from the test scores one can estimate the grades which a student will make in college. If the test scores are not related to the grades received by students the test is not a valid measure for predicting college scholarship.

B. Reliability

The extent to which a test measures consistently (regardless of what it measures) is called the *reliability* of the test. For example, if a test is administered to the same group of subjects on two different occasions, say a month apart, the relative standing of the members of the group should be approximately the same at both times. If there is much shift in the ranks of the individuals taking the test on the two occasions the test is not a reliable measure of the performance.

XI. MENTAL GROWTH AND THE PREDICTION OF MENTAL LEVEL

Intelligence as capacity develops until maturity. Yearly tests of the same children, with the same tests, show that higher scores are made at each succeeding year (Baldwin and Stecker). Children six years of age answer more questions than they did at five. Growth is illustrated by testing children of all ages and tabulating the scores by ages. The average score of ten year olds is higher than the average of nine year olds, the average of nine year olds is higher than that for eight year olds, etc. (Terman, 1916).

A. Growth Curves

The curve of mental growth is a logarithmic curve characterized by *negative acceleration*. Heinis (1926) derived the formula for the curve of mental growth (y) as follows:

$$y = \beta\left(1 - e^{-\frac{x}{d}}\right)$$

where: β and d are constants
e is the natural log
x is age

Mental growth seems to be complete by the time the average individual reaches his sixteenth birthday (Terman, 1916). Eighteen year olds, twenty year olds, or twenty-five year olds, do not make higher scores on intelligence tests than do sixteen year olds. For this reason intelligence is said to have matured for the average individual by the age of sixteen. In fact, many investigators have found that the average growth is complete by fourteen or fifteen years and they hold that sixteen years is too high a figure for average mental maturity (U.S. Army results). Thus fourteen, or fifteen, or sixteen, is used as the maximum age for the computation of the I.Q.

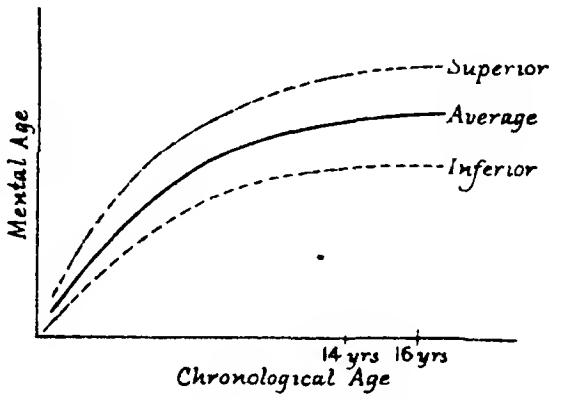

Figure 9 *The Growth or Maturation of Intelligence* These curves illustrate the relation of increases in intelligence (Capacity as measured by M A) to increases in age (C A) After 14 to 16 years C A the curve stays level until late maturity, then it gradually decreases The curves indicate growth for groups of superior, average and inferior subjects

Children of superior intelligence start at a higher level and continue to be higher throughout the entire period of growth; similarly, the inferior start lower and stay lower to maturity.

8. Correction of the I.Q. for Prediction of Mental Growth

The I.Q., which is the ratio of M.A. to C.A., is used often for the prediction of future mental growth. While it is fairly constant from age to age, the I.Q. does not take into consideration, as a predictive measure, the changes in the growth curve. The more accurate ratio for the prediction of mental growth is the *Personal Constant* (*P.C.*) of Heinis (1926). P.C. is the ratio of tested age (M.A.), corrected by Heinis' formula for mental growth, to life age (C.A.), corrected by the same formula.

The P.C. is more constant from age to age than the I.Q. Mental ages for four groups of subjects predicted from the I.Q. five years in advance were in error by 1.5 years while those predicted from the P.C. were but .2 of a year in error (Riley, 1930).

XII. THE DISTRIBUTION OF INTELLIGENCE

Extensive testing of large numbers of persons with the same environmental background (e.g. approximately equal social, educational, racial, and financial status) and equal in age has led to certain generalizations regarding the distribution of intelligence.

A. Intelligence is Normally Distributed

It was found early that measures of anthropological and physical characteristics were distributed according to the *normal probability curve.* Measures of intelligence are likewise normally distributed. People cannot be classified as intelligent or unintelligent; it is a case of more or less.

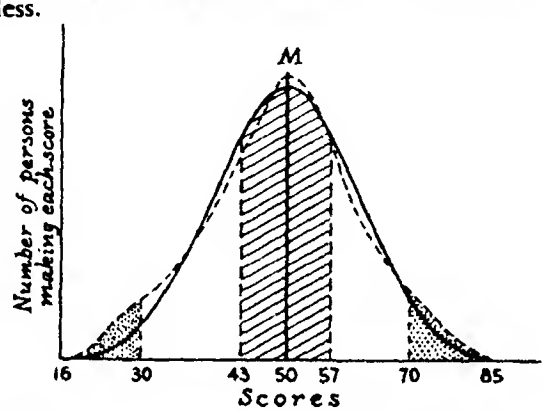

Figure 10. *The Normal Distribution of Intelligence Test Scores.* This figure (broken line) shows the distribution of scores made by 6,520 nine year old children who took a 100 item intelligence test. Scores ranged from 16 (the lowest score) to 85 (the highest score). Fifty percent of the group (3,260) scored between 43 and 57 as indicated by the cross-hatched area. Two percent scored below 30 and two percent scored above 70 as indicated by the dotted areas. The average score for the group was 50, indicated by the vertical line M (the *mean*). The solid line indicates the shape of the theoretical normal distribution curve which would be obtained if all nine year olds were tested.

The normal curve is bell-shaped and bilaterally symmetrical on each side of its *central tendency,* the *mean.* Just as many individuals possess intelligence above the average as below it. Starting with the lowest score on an intelligence test there is a gradually increasing number of persons making each score until the average score is reached. Then the number of individuals making each score above the average gradually decreases to the highest score.

B. The Range of Intelligence

In any large unselected group of persons a wide range of intelligence is found. The person making the lowest score is very low in comparison with the one who makes an average score. Similarly, the highest scoring individual is very high. The ratio of the highest score to the lowest score, in a distribution from a large unselected group, is roughly as 3 to 1.

C. The Distribution of Intelligence Quotients

A normal distribution of intelligence, such as the following, is found for the total population.

I.Q. Range	*Percent of the total distribution*
Below 70	1%
70-79	5%
80-89	15%
90-109	58%
110-119	15%
120-129	5%
Over 130	1%

Although some writers present slightly different figures they are not found to deviate by more than a few points in any class and practically all agree in the highest and lowest classes. These results are based on I.Q.'s from the Stanford-Binet test.

D. Distribution of Scores from Group Tests

Results of group testing show the same wide range and normal distribution of scores as found on individual examinations. On the Army Alpha test, for instance, college freshmen score as low as 100 points and as high as 190. Less selected groups range from 10 to 203.

E. The 'Type' Theory

There is a popular belief in 'psychological types.' Early in the history of psychology it was thought that people could be classified into well-defined groups or 'types.' The normal distributions of scores on tests of psychological activities have emphasized the fallacy of this theory. For such a theory to be valid a distribution of measures would have to be *multimodal*. Such distributions are not found except where groups of people are selected from the extremes of a normal distribution. For example, the classification of people into intelligent and unintelligent types is accomplished by naming various segments of the normal distribution curve.

XIII. LEVELS OF INTELLIGENCE

The meaning of the scores obtained from intelligence tests is shown by the distribution of intelligence quotients. The following classification has been proposed:

I.Q. Range	*Classification*
Below 70	Feebleminded
70-79	Borderline
80-89	Backward or Retarded
90-109	Normal
110-119	Accelerated
120-129	Bright
130-139	Very Bright
Over 140	Genius or Near-Genius

A. Feeblemindedness (Amentia)

Selection of the feebleminded requiring institutional care is dependent in a large measure on intelligence, but it is based also on other adjustive and social criteria. One who has an I.Q. of 68, for example, is not confined to an institution for the feebleminded unless his adjustment in his environment justifies the procedure.

Individual differences among the feebleminded are wide and three sub-classes of amentia are defined.

1. Morons. Morons are the superior feebleminded. Morons have intelligence quotients between 50 and 70. For adult persons this is equivalent to a mental age of 8 to 11½ years.

2. Imbeciles. Imbeciles are lower in intelligence than morons and have I.Q.'s between 20 and 50 (adult M.A. of 3 to 8 years).

3. Idiots. Idiots are the lowest in intelligence, having I.Q.'s below 20 and, as adults, mental ages of less than 3 years.

The feebleminded are capable of earning a living and caring for themselves only under very favorable circumstances. They cannot compete on equal terms with their more normal fellows and seldom manage their affairs with ordinary prudence. The intelligence of the feebleminded is over-rated frequently by normal people.

The high grade moron usually can complete the first three or four grades of elementary school but fails frequently and is considered stupid by his teachers and fellow students. The imbecile cannot learn to read, spell, or do arithmetic. He seldom acquires much of a speaking vocabulary. With very careful instruction he may learn simple motor tasks. The idiot is incapable of learning to any noticeable degree. He requires close supervision and care in such simple habits as eating, dressing, and cleaning himself. His behavior is on a very primitive level and speech is seldom acquired by the idiot.

B. Superior Intelligence

Intelligence quotients of 120 and above indicate superior intelligence. This includes about 6 percent of the population. The intelligence of the superior is usually under-rated by normal people who seldom realize what superiors are capable of doing.

Hollingworth (1916) describes the accomplishments of a child 8 years and 4 months of age with an I.Q. of 187. He was in the eighth grade in school and had a good knowledge of high school mathematics, algebra and geometry. He read or conversed in Latin, French, German, Spanish, and Italian. He also knew the Greek alphabet, some Hebrew and some Portuguese. He knew most of the astronomical constellations and was interested in, and adept at, history and nature study.

Most men who later became eminent as scientists, philosophers, and writers were, as children, very superior and would have scored very high on intelligence tests (Cox, 1926). Contrary to popular opinion, superior children are likely to be taller, heavier, and in better health than less gifted children (Terman, 1925).

XIV. GROUP DIFFERENCES IN INTELLIGENCE

Society is formed of many social groups and the question of group differences in intelligence has received considerable attention from psychologists. Overlapping of groups is common and often the ranges of different social groups are equal where the average scores for the groups differ. Although groups differ there are greater differences among the individuals in the groups than differences between the groups.

A. Sex Differences in Intelligence

No appreciable sex differences in intelligence exist. Boys do excel girls on tests of arithmetic, reasoning, spatial relationships, etc., while girls excel on tests of memory, etc. Terman (1916) found that girls were slightly better than boys in general abstract intelligence until the age of 13, but from then on there was no difference. This early difference may be a function of the earlier and more rapid maturation of girls. College men were found to have slightly higher average scores than college girls on intelligence tests such as Army Alpha (Hill et. al., 1919; Arps and Noble, 1921). On the other hand, Boynton (1926) found no sex difference.

B. Race Differences in Intelligence

Differences in the intelligence reported here for various racial groups are to be interpreted with certain reservations. Errors in the results of studies of racial differences are likely to arise because: (1) Tests developed for use with individuals of one racial group are not always equally applicable to measurement of other groups. (2) Some racial groups are at a disadvantage because of language deficiencies. (3) The groups tested may not be representative samples of the total racial group considered (the sampling error).

1. Between Whites and Negroes. Comparisons between groups of whites and negroes, born in the United States and of equal chronological age, show that only 25 percent of negroes equal or exceed the median score of the white groups. The average I.Q. of the negroes is about 85 and of the whites is about 100. These results have been found with both verbal and non-verbal tests. The average I.Q. of negro col

lege students was 103, while the average for white college students was 112 (Derrick, 1920). The percent of negro freshmen in seven negro colleges which equalled or exceeded the median scores on the same test of white freshmen in white colleges were 9, 10, 12, 18, 23, 27, and 43 (Price, 1929). Comparison of the distributions of scores on nine tests of abstract intelligence for a group of students in a negro college and students in a white college show that the percent of negroes equalling or exceeding the median score for the whites on the various tests was 28, 30, 30, 33, 36, 40, 45, 55, and 57 percent (Graham, 1930). In general, differences in intelligence found between whites and negroes favor the whites. This may be a real social group difference, or it may be due to unequal opportunity in the training upon which the testing is founded.

2. Other Racial Groups. Other racial groups, such as, American Indians, Jews, Mexicans and Orientals, have been compared with the white population.

a. *Amerinds.* The average I.Q. of Amerinds (American Indians), when measured by verbal tests, is about 85; but when measured by non-verbal tests the average is about 95. Full blooded Indians are somewhat lower than Indians having some white blood.

b. *Jews.* In the United States, and in England, the average I.Q. of Jews is three or four points higher than the standard of 100. A greater portion of superior children were from Jewish families than might be expected from the percent of Jews in the total population (Terman, 1925).

c. *Mexicans.* Mexicans in the United States are inferior to whites on practically all tests.

d. *Orientals.* Orientals in the United States and Canada are about equal to whites on practically all tests. This is particularly true when measurements are made with non-verbal tests.

3. Northern and Southern Europeans. Immigrants from northern Europe are about equal to native whites in the United States. Immigrants from southern Europe are slightly inferior to native white groups. In Europe, the northern Europeans are slightly superior to the southern Europeans.

C. Occupational Differences in Intelligence

Surveys of the intelligence of persons engaged in the various occupations have invariably shown that the professional groups score high, the skilled trades and technical and clerical occupations in the middle, and the unskilled trades, tradesmen, and laborers score low.

The Army Alpha tests, administered to soldiers during the World War, revealed the following occupational differences (Yerkes et. al., 1921):

Occupation	*Median Score (Army Alpha)*
Laborer	47
Farmer	48
Miner	49
Teamster	50
Tailor	53
Barber	55
Baker	59
Machinist	63
Auto Mechanic	66
Plumber	66
Policeman	69
Electrician	80
Telegrapher	84
General Clerk	95
Bookkeeper	100
Mechanical Engineer	109
Draftsman	114
Stenographer	115
Civil Engineer	116

D. Socio-economic Status and Intelligence

The average intelligence of children from homes of superior social and economic status is higher than that of children from average homes. The difference is from 5 to 7 I.Q. points. Children from distinctly inferior homes are about the same amount lower than those from average homes (Collings, 1928). Intelligence may be thought of as one of the causes of socio-economic status.

E. Geographical Location and Intelligence

For the measurements reported there seem to be slight differences in intelligence levels of children in various sections of this country (Woody). There also seems to be a slight intelligence advantage of urban over rural children (Baldwin). These differences may actually be due to racial, economic, or other discrepancies in the groups.

XV. DELINQUENTS AND CRIMINALS

The intellectual level of delinquents and criminals is not definitely established. The popular notion, perhaps based on early investigations, that a very large portion of offenders are mentally deficient has not been supported by recent experimental studies. Results of studies of delinquents and criminals must be interpreted with certain reservations: (1) perhaps a greater percentage of the less intelligent offenders are apprehended, and (2) repeated offenders are more likely to be incarcerated. Since studies are usually made on inmates of institutions the experimental group is not an unselected sample of offenders.

A. Average Intelligence of Offenders

Various investigators have found the average I.Q. of groups of offenders to vary from 80 to 90 for different institutions. Healy and Bronner (1926) report an average of 90 for 4,000 repeated juvenile delinquents and Sullivan (1927) found the same average for inmates of a boys' reformatory. Root found an average I.Q. of 76 for 1916 male adults in a penitentiary and Adler found an average of 78 for boys in a reformatory. Practically all other investigators, especially in recent years, have found averages between 80 and 90 I.Q.

B. Feeblemindedness Among Offenders

Early investigators found high percentages of feeblemindedness among delinquent and criminal groups. The percentages were: 93 percent (Hill and Goddard, 1911), 89 percent (Bridgman, 1913), 66 percent (Pyle, 1914), and 9 to 11 percent (Bronner, 1914). In general, later investigators have found much lower percentages, as: 4 or 5 percent (Boynton, 1926), 7 percent (Miner, 1918), 8 percent (Burtt, 1925), 31 percent (Adler, 1928), 13 percent (Healy and Bronner, 1926), and 21 percent (Oseretzky, 1928). The more favored estimate of the proportion of mental defectives among offenders is about 20 percent. This percentage is much greater than that for the feebleminded in the total unselected population, which is given by Doll as one percent.

C. Type of Crime

While the evidence is not conclusive, there is some correlation between the type of offence committed and the intelligence of the offender. Embezzlement, fraud, robbery, and forgery are offences of more intelligent persons than are arson, sex offences, and felonius assault (Murchison, 1926; Merrill, 1926).

XVI. SUMMARY

Intelligence, then, may be thought of as a capacity for learning, thinking and adjusting in new situations. It is a native capacity and is probably a correlate of structural and functional characteristics of the organism. Three 'kinds' of intelligence: abstract, concrete, and social, are differentiated for the practical purposes of measurement and tests for these general capacities, as well as for numerous special capacities, are available. Tests are standardized experiments. They are used for the quantitative estimation of amount of intelligence (capacity).

Intelligence is the capacity for development; learning is a process of development.

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CHAPTER VII

LEARNING

INTEGRATIVE ACTIVITY

Learning may be viewed as a change in stimulation (conditioned stimulus) or as a change in reaction (reorganized reaction), as described in Chapter III. It is psychological activity (behavior) in development. It is a process of integration which increases the likelihood that a given reaction (frequently referred to as *response* in discussions of learning) will follow a given stimulus upon its repetition. It is defined as the perfection of adequate *connections* between stimulus and reaction (integrative activity).

I. FORMS OF LEARNING

Because of their distinguishing characteristics, several kinds of learning are described.

A. Habits

When learned simultaneous or successive pattern reactions have become 'automatic' they are called habits. Some authorities make a distinction between motor habits and language habits. In fact all learning that has become well established, or has reached a high degree of automaticity, may be thought of as habit. The 'behaviorists' use the term to include all learned reactions.

B. Memory

When the learning is largely implicit (verbal, linguistic, or symbolic), with relatively unobservable motor activity, it is spoken of as memory. Memory is described in four genetic stages (Dashiell).

1. Acquisition—the organization and practice of the reactions.
2. Retention—the permanence or duration of the reactions.
3. Recognition—a test of learning. The learner is able to recognize previously learned material.
4. Recall—another test. The learner reproduces the previously learned material.

These steps are also called by some writers (Warren and Carmichael) impression, retention, recognition, and revival, respectively.

Memory is further described in terms of the methods of reproduction of the learning.

1. 'Rote memory'—in which there is *verbatim* or exact literal reproduction (as in memorizing the multiplication tables or the alphabet).
2. Memory for content—in which there is a reproduction of certain elements of the total situation.
3. Memory for context—in which the learner reproduces the general ideas or meanings of the learning situation.

C. The Conditioned Reaction

The conditioned reaction, or conditioned reflex, described earlier (pages 51 ff.), is a form of learning. Many authorities hold that the conditioned reflex is the essential mechanism of all learning, other forms of learning being no more than the operation of the principles of conditioning in complex situations.

D. 'Motor Learning' vs. 'Mental Learning'

In early experiments it was found that the course of learning was different when the reactions were primarily explicit and when they were implicit. This led to descriptions of motor and mental (sometimes called language) learning. Most authorities have abandoned this distinction as experimentally unjustified.

E. Forgetting

Forgetting is the converse of learning. The curve for the process of forgetting is approximately the inverse of the curve for the process of learning.

II. METHODS OF STUDYING LEARNING

The experimental techniques for studying learning activity vary according to the learners used, the kind of learning, and the type of learning materials. In all cases, *criteria* of learning are established as standards of perfection.

A. Criteria of Learning

The general *criteria of learning* are quantitative measures of performance (accomplishment), as indicated by *amount, time* (*speed*), and *errors* (*accuracy*). Learning is said to take place when (a) the amount increases, (b) the time of a definite increase is reduced, and (c) the number of errors is reduced. Forgetting is indicated when these measures are in the opposite direction. The general criteria of learning are applied as measures of both animal and human learning.

1. Special Criteria of Language Learning. *Recall* and *recognition* are special criteria of *amount* of performance and they are used as measures of language learning.

a. *Recognition*. The material which the subject (S) has been learning is presented along with other material and S is required to indicate the items he recognizes as having observed before in the experiment. The fact that he is able to recognize the proper items is taken as evidence that a certain amount of learning has occurred.

b. *Recall*. S is required to recall or reproduce the material he has been learning.

2. Threshold Learning and Overlearning. When a reaction has been learned to the point where the learner can make one complete errorless repetition it is said to be learned to the *threshold* (threshold learning). Learning which proceeds beyond the threshold is called *overlearning*.

3. Other Criteria. Experimenters often set up other arbitrary criteria, such as 75 percent of perfect responses, 5 consecutive errorless trials, a saving of time or trials on relearning after a period of time, etc., as the criteria of learning.

B. Tasks (Materials, Problems) for Studying Learning

Learning tasks are samples of psychological activities, which are selected by experimenters to study the process of learning. Standard materials for the investigation and measurement of the explicit reaction in learning, which are used for both animals and human subjects, include problem boxes, mazes, discrimination and delayed reaction apparatus.

1. Problem Boxes. S is placed in a situation where he must learn certain reactions to escape confinement or secure other appropriate reward. This is a learning task. S may be required to pull the correct string or strings, to manipulate latches or levers, or to step on contacts in the floor in a certain sequence to solve the learning problem. Measures of learning are the time required to solve the problem (a decrease in subsequent times showing the progress of learning), the number of errors committed (a decrease in errors indicating learning), or some similar measure.

2. Mazes. S is placed in a starting compartment from which he must traverse a path containing *culs-de-sac* (blind alleys) to get the reward. The measure of learning may be time, errors, or number of trials. Paper and pencil, or other 'tracing mazes,' are used with human subjects.

3. Discrimination Apparatus. Problem apparatus is used as a learning task, in which S must learn to make differential reactions to different sensory stimuli, such as turning left when confronted with a

triangle and right if the stimulus is a circle, or the pressing of a key with the right hand if a light is red and with the left hand if the light is green. Again, the required response may be to jump to a platform, or make a turn in a maze, etc.

4. Delayed Reaction Apparatus. S may be placed in a 'choice situation' as a learning task, in which the reaction must be delayed for a time after presentation of the stimulus. The measure is the maximum delay following which the learner can make the correct reaction, or the percent of correct reactions following a given period of delay.

5. Materials for Human Subjects. Complex motor activities have been measured by such tasks as typing, telegraphy, and throwing darts. Complex language (symbolic) activities have been measured by such tasks as written or spoken words, non-sense syllables, picture completion, abstracting common elements.

III. ANIMAL LEARNING

Knowledge of animal learning prior to 1890 consisted of anecdotal accounts of remarkable feats (Romanes, Mobius and others). Most of this information is inaccurate. The first rigidly controlled experimental studies of animal learning are credited to Thorndike (1898), who studied learning in chickens, cats, fish, and other infra-human subjects.

A. Watson's Classification of Learning in Animals

Watson (1914) distinguished several kinds of learning in animals.

1. Motor Habits. Motor habits are learned explicit patterns of behavior. Watson makes two divisions of motor habits: (a) 'motor habits in the narrow sense,' such as are involved in running mazes, and (b) manipulation habits such as the handling of objects and the solving of problem boxes.

2. Sensory Habits. Sensory habits are differential reactions to varying environmental stimuli, such as are involved in discrimination experiments.

3. Delayed Reaction Habits. Habits of this kind involve very complex sensitivities and reactions, but the overt reaction is delayed for a period of time.

B. Learning at Various Levels of the Animal Evolutionary Series

Experiments have shown that learning in some degree is possible in animals at all genetic levels from amoeba to man. The chief differences are in (1) the complexity of the reception of stimulation, (2) the complexity of the reactions that are learned, and (3) in the permanence of the learning.

Representative studies have shown that amoeba learn to avoid a beam of light (Mast, 1924), paramecia learn not to ingest grains of carmine (Metalnikow, 1912), sea-anemones learn to distinguish food from filter paper (Fleure and Walton, 1907), earthworms learn to 'run a T Maze' (Yerkes, 1912), minnows learn to swim through simple mazes (Thorndike, 1898), pike and perch, after bumping their noses on glass partitions in an aquarium, will not attempt to eat minnows which formerly were behind the partition (Mobius, 1873 and Triplett, 1901), chickens learn to solve simple mazes (Thorndike, 1898) and to peck food accurately (Breed and Shepard, 1913), cats learn to escape from problem boxes by pulling strings and manipulating levers (Thorndike, 1898), white rats become proficient at running mazes and solving problem boxes (numerous investigators) and even discriminating between geometrical figures (Fields, Lashley, and others), and anthropoids learn to solve complex problem boxes (Yerkes and others), and to make and use tools (Kohler, Yerkes and others), and to use 'money' in purchasing food (Jacobson) and even more abstract feats.

In general, as the complexity of structures increases for reception, integration, and reaction, there is a corresponding increase in the complexity of the tasks that can be learned and in the permanence of the learning.

C. How Animals Learn (Generalizations)

The experimental studies mentioned above, and many other similar studies, are fairly unanimous in indicating certain general features of the learning process in animals.

1. Trial-and Error. Nearly all experiments indicate the presence of trial-and-error (trial-and-success) learning. Trial-and-error learning is 'random reaction and accidental success.' When the animal is first placed in a new situation, as the cat in the problem box, the behavior is 'random.' Success in the solution of the problem is accidental. This blind groping continues until the animal has succeeded several times. There is a gradual elimination of the unsuccessful or unnecessary reactions and establishment of the successful one. Finally, when the animal is placed again in the problem situation, he immediately reacts in such a way as to complete the solution.

2. Insight. In some experiments with animals, especially the higher apes, a different kind of learning behavior is observed. This is called *insight*. The animal makes few random reactions, there is a sudden elimination of unsuccessful reactions, and the problem is solved perfectly from then on. This sudden 'grasping of the idea' is said to be similar to reflection (thinking) in humans. It may be explained as implicit trial-and-error (Tolman).

3. Motivation. Learning does not occur unless the animals are motivated to make the required reactions. (see Chapters IV and V).

4. The Principle of Least Effort. Certain investigators have concluded that the final solution of a learning task, admitting of more than one solution, will always be such as to require the least effort on the part of the learner (DeCamp, 1920; Kuo, 1922; Gengerelli, 1930).

The above brief list is illustrative of the generalizations that have been formulated as a result of learning experiments with animals. Other principles, which hold for animals as well as humans, will be discussed in subsequent sections on learning in humans.

IV. HUMAN LEARNING

Special caution must be taken against drawing conclusions regarding human learning from experiments on animals. Differences in the genetic development of organs, for instance the "Brain of Rats and Men" (Herrick, 1926), are facts in point. But the ease of imposing controls on animals makes them popular subjects for experimentation and especially in studies involving surgical techniques. On the other hand access to the symbolic processes (language) of humans and the practical value of experiments using human subjects offsets the advantages of animal subjects.

A. Experimental Methods

Studies of human learning are carried on both in the laboratory and under natural conditions. Laboratory studies are desirable because they allow for better experimental control. Some investigators believe that an artificial situation is created in the laboratory and the course of learning is not the same as under natural conditions. There are two experimental methods for the study of human learning.

1. Single Group Method. A single group of subjects is tested, *trained,* and retested. Tests may be made at various times during the training period. The course of learning in the individual and in the group is measured, but no control is present for comparative purposes.

2. Parallel Group Methods. In this method two groups are used: (a) an *experimental group,* which learns the task under the influence of the new learning conditions (stimulation), and (b) a *control group,* which learns under constant conditions where the motivation being studied is not present. The two groups are either selected at random or equated. They may be equated by selecting groups so that each has the same average intelligence, age, initial performance, and so on. A better plan is to pair individuals in each group (*paired group method*). A refinement of this technique is illustrated in *co-twin controls,* where identical twins are used as subjects and one member of each pair is placed in each group.

B. The Extent of Learning in Humans

Learning continues throughout the entire life span of any normal individual. There is apparently no time prior to death when one cannot perfect reactions. Investigations have shown that the degree of efficiency in learning increases with age to about 20 or 25 years, remains almost stationary to about 45, then gradually decreases until death (Thorndike, 1928). More recent results (Miles and others) indicate that the usual decline found after 45 need not take place under adequate motivating conditions.

V. THE PROGRESS OF LEARNING (LEARNING CURVES)

The progress of learning is shown graphically in a *learning curve*. This is a graph of the relationship between some measure of learning (errors, time, amount) on one axis (*ordinate*) and the number of trials, or length of practice, on the other (*abscissa*). Controlled motivation is assumed.

A. Individual and Group Curves

Plotting the progress of one (or a small number of) learner gives a curve which is very irregular. Wide variations and many fluctuations are characteristic of all individual curves, but a continual decrease in errors or increase in performance is shown in the curves. If the results

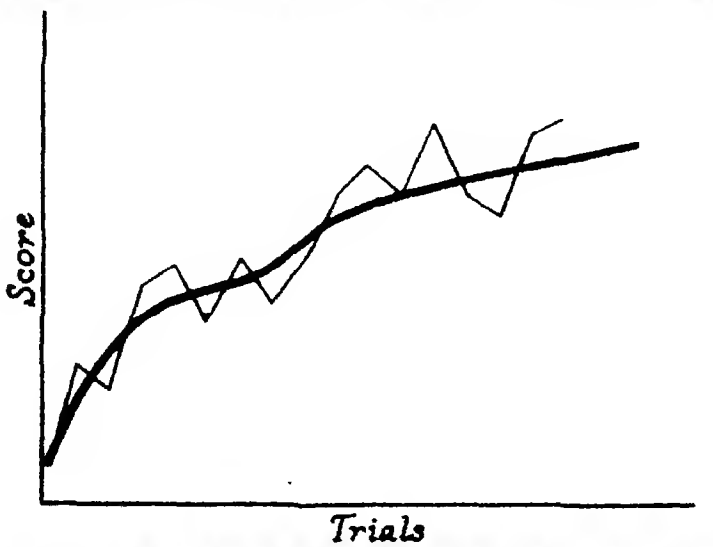

Fig. 11. A comparison of an individual learning curve, (the irregular light line) and a smooth curve plotted from averages for 25 subjects.

for a group of learners are averaged, and the averages plotted, the curve loses its irregularities and becomes smooth. The continual increase in learning until a final level of attainment is reached is always indicated.

B. Forms of the Learning Curve

The two chief forms of the learning curve are: (1) *convex curves*, and (2) *concave curves*. They differ in the rate of the learning. The

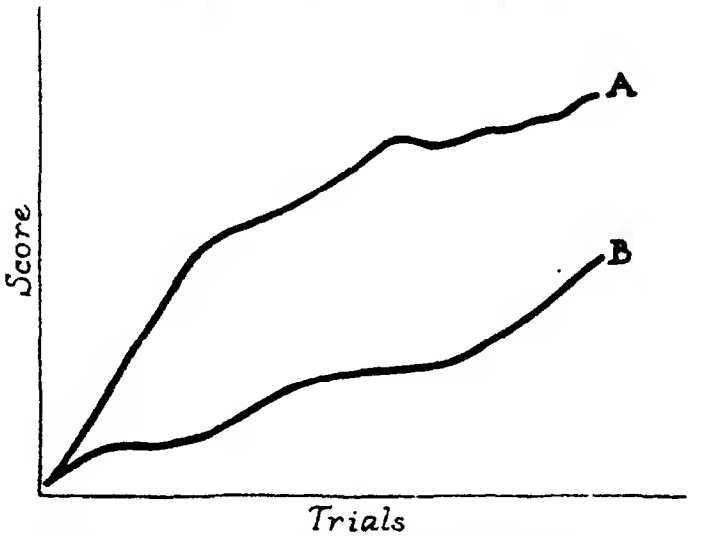

Fig. 12. A convex curve (Curve A) from motor learning and a concave curve (Curve B) from language learning.

convex curve indicates a rapid start with a decreasing rate of improvement as the learning proceeds (negative acceleration). The concave curve shows a slower rate of improvement at first, which increases with successive trials (positive acceleration). Occasionally both shapes appear in the same curve with a *plateau* between them.

C. Variations in the Learning Curve

A learning curve may be divided into segments showing variations in the progress at various stages of learning.

1. Initial Spurts. At the beginning of learning, progress may be very rapid. There may be *transfer* from previously learned reactions, interest in the task, or special motivation, which account for the initial spurts. The initial spurt is often followed by plateaus.

2. Plateaus. Plateaus are segments, especially in individual curves, where the curve flattens out and there is no measurable progress in the learning. Various explanations have been offered for plateaus. The first learning integrations may undergo a period of automatization (habituation or 'stamping in'), the intent of the learner may be changed, fatigue and boredom may arise, or other conditions may account for plateaus.

3. End Spurts. Toward the completion of learning an end spurt often appears in the learning curve. This represents a period of rapid progress, but one which usually is not as rapid as in the initial spurt. End spurts may follow a plateau where the curve contains other plateaus in addition to the final plateau.

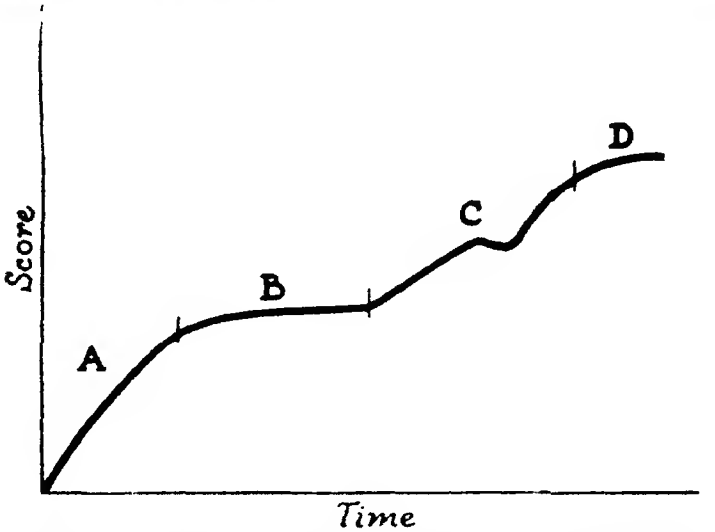

Fig. 13. A hypothetical learning curve showing the initial spurt (A), the plateau (B), the end spurt (C), and the final plateau (D)

4. End Plateau. The learning curve becomes a flat line parallel to the abscissa in its latter stages. This may be due to a *physiological limit* having been reached in the learner, but more probably it is caused by a realization of the goal. As motivation is increased the curve will rise to a still higher level.

D. Mathematical Statement of the Learning Curve

Many attempts have been made to derive an equation for the generalized learning curve. Meyer, for example, gives the following equation:

$$t = K \text{ arc cot } (n+p) + t'$$

where: t = Performance time
K = A constant
n = Number of the trial
p = Amount of practice at first trial
t' = Shortest time of performance

No equation fits all learning curves exactly, because of wide differences in the individual learners and in the tasks and methods of the experiments.

VI. CONDITIONS OF LEARNING (GENERALIZATION)

From experimental studies of animal and human learning certain generalized conclusions may be made. Some of these have already been listed to indicate how animals learn (page 103-4).

A. Trial-and-Error

Just as trial-and-error (trial-and-success) was observed in the learning behavior of animals, so also is it found in human learning. This is particularly true in learning to solve puzzles and in other manipulative tasks. Some authorities hold that in verbal learning the same trial-and-error methods are present but that the reactions are sub-vocal. There is probably more 'insight' behavior in human learning than in the learning of animals.

B. Intelligence

There is a high degree of relationship between scores on intelligence tests and learning both as regards rate and permanence of learning.

C. Physical Condition

Learning is directly related to the physical condition of the learner. Removal of adenoids and tonsils resulted in improvement of learning (MacPhail, 1920). Treatment and elimination of hookworm resulted in improvement in learning (Strong). Fatigue affects accuracy in learning very little, but when both speed and accuracy are considered the general efficiency of learning is greatly reduced (Friedrich, 1897; Thorndike, 1900, and others).

D. Motivation

To learn, the learner must be motivated to learn. He must have a goal for learning (see Chapters IV and V). This goal is in awareness as intent to learn. Changes in intent are accompanied by changes in performances (Fryer, 1934).

E. Whole vs Part Learning

In general, a task learned as a whole is more efficiently learned than when learned in parts (Steffens, 1900; Pyle and Snyder, 1911). Some contradictory results to this generalization have been reported. Pechstein (1917) in a study of maze learning and Winch (1924) in a study of memorizing poetry showed that the part method was more efficient. If the material to be learned is long, a combination of the part and whole methods is more efficient than either one alone (Reed, 1924). These results indicate that the method of learning varies in its efficiency according to the task to be learned.

F. Distribution of Practice

Learning is more efficient when practice is distributed at intervals over a period of time than when it is concentrated in one period, as in 'cramming' (Ebbinghaus, 1885; Leuba and Hyde, 1903; and others).

G. Active vs Passive Learning (Recitation)

Active participation in the learning task (recitations, verbalizations, and other activities) increases the efficiency of the learning process (Gates, 1917).

H. Grouping

Grouping materials of similar kinds together increases efficiency of learning and retention.

I. Environmental Conditions

Optimal environmental conditions for learning include: (1) temperature at 68° F, humidity at 50%, and 45 cu. ft. of fresh air per minute (Thorndike, McCall, and Chapman, 1916).

J. Sensory Presentation of the Task

There are wide individual differences in the efficiency of learning as related to the sensory presentation of the task. For some individuals visual presentation is better, for others auditory, and for all, both forms of presentation.

K. Mnemonic Devices

Mnemonic devices are aids to memory, e.g., "Thirty Days Hath September etc.," "Columbus sailed the ocean blue in fourteen hundred ninety two," and "On Old Olympus Piney Top etc." In many cases these devices are helpful but their benefits come from their novelty or interest, the increased number of associations they arouse, and the over-learning resulting from more frequent review of the material to be learned. In general, mnemonics are best when they are logically related to the material to be remembered, when they are rich in associations, and when they are devised by the learner rather than being given him as so much more material to be learned.

L. Speed and Permanence

Numerous investigators have shown that speed of learning is related to permanence of the learning. One who learns rapidly will also remember better than slow learners.

VII. OTHER CONDITIONS OF LEARNING WITH GENERAL EDUCATIONAL SIGNIFICANCE

Highly controversial psychological questions in education relate to: (1) the *transfer of training*, (2) *cross education*, (3) *formal discipline*.

A. Transfer of Training

By transfer of training is meant the effect on one activity of practice in another activity. The problem of transfer is considered in two fields (Starch): (1) transfer in specific psychological activities and (2) transfer in school subjects.

1. Transfer in Specific Psychological Activities. Studies under this classification include transfer activities in memory, estimation of lengths, estimation of weights, letter and word cancellation, maze learning, puzzle solving, etc. Experimentation on this problem started with James (1890). He investigated the effect of memorizing one kind of material on ability to memorize other kinds of material. His experiment is illustrative of many others: 158 lines from Victor Hugo were memorized in 131 minutes over a period of 8 days; then practice on memorizing *Paradise Lost* proceeded for 38 days (20 minutes per day); finally, another 158 lines from Hugo were memorized in 151 minutes. This shows a *negative transfer.* Training in estimating the length of lines from one-half to one-and-one-half inches in length produced no improvement in estimating longer lines; but training in cancellation of some letters improved the cancellation of other letters (Thorndike and Woodworth, 1901). Training in judging weights of various sizes transferred to estimation of other weights (Coover, 1916). These experiments showed *positive transfer.* A typical experiment by the parallel group method was reported by Kline (1909). He tested two groups on cancellation of nouns, pronouns, etc.: one group practiced cancelling certain letters and the other group had no practice. The untrained group was better than the trained group on an end-test of cancelling nouns, etc., thus showing negative transfer. Practice on one maze transferred to learning on another maze for both rats and humans (Webb, 1917). An experimental group practicing memorizing poetry showed greater positive transfer to memorizing historical prose than did a control group which had practiced solving arithmetic problems (Winch, 1908). From these studies of transfer two conclusions may be drawn: (a) both negative and positive transfer occur between specific learning activities; (b) the more similar the specific activities, the greater will be the positive transfer, and as the activities are more dissimilar the greater will be the negative transfer.

2. Transfer in School Subjects. Most of the experimental studies of transfer in the school subjects have been made by the paralled group method. High school freshmen who studied Latin made slightly higher scores on an English vocabulary test than did non-Latin students, and the gains were all on words derived from Latin roots. The non-Latin group did just as well on non-Latin words as did the Latin group (Thorndike and Ruger, 1923). Using a vocabulary test composed of words from French roots, a Latin student group showed the greatest transfer, a non-foreign language group was next, and a French student

group showed the least transfer (Woody, 1930). Transfer from Latin to English vocabulary was great when word derivations were stressed in the teaching of Latin (Hamblen, 1924). Practice in 'arithmetical computation' did not transfer to 'arithmetical reasoning' (Winch, 1923). Training 'in neatness on arithmetic papers' did not produce greater neatness on papers in other subjects (Squire, 1922). Students who had studied Latin and Greek in high school made higher scores on the College Entrance Board examinations than did non-classical students (1917). A group of 17 Latin students were slightly superior to a group of 17 non-Latin students in English grammar, composition, and derivations, but were not superior in spelling, definitions, reproduction and dictation (Dallam, 1917).

In summary, it may be said that there is very little evidence in favor of any appreciable amount of transfer in school subjects. The benefit of studying or learning subject-matter because of its transfer value alone is very slight.

B. Cross-education

The transfer from one organ of the body to the similar organ on the other side of the body is called cross-education. For example, the training of the right hand on a certain function improves the accomplishment of the left hand in the same function. Practice in accuracy of hitting dots with one hand transfers and increases accuracy in hitting dots with the other hand (Woodworth, 1899). Training in mirror tracing with the right hand transfers to the left hand (Starch, 1910). Tapping with the large toe of the right foot transferred most to tapping with the large toe of the left foot, somewhat less to tapping with the right hand, and still less to tapping with the left hand (Davis, 1908).

C. Formal Discipline

Generalized transfer is the basis of the theory of 'formal discipline'. Greek, Latin, logic, geometry, and other subjects have been included in educational curricula because of the disciplinary value which they were thought to have in 'improving the mind'. Practically all evidence, as indicated above, is opposed to such a theory.

D. Theories

There are two theories which attempt to account for the transfer of training and cross-education.

1. The Theory of Identical Elements (Thorndike). Transfer takes place only insofar as there are identical elements in the two kinds of activity. This identity may be traced in the activities of the nervous system. The identical elements of practical importance in education are said to be associations and ideas of method and general principles.

2. The Theory of Generalization (Judd). According to this theory the transfer occurs because of a generalizing ability in the learning of relationship. Such generalizing is of the nature of recognition or insight into the learning problem which is gained through previous experience.

E. Some Practical Implications of Transfer

In all cases the amount of improvement due to transfer is less than the amount of improvement which would have obtained had the same amount of time and energy been spent directly in the activities to which transfer is made. If the only value of training is its transfer, then this learning has little justification. A more important conclusion from the investigation of transfer relates to intent or attitude. The amount of transfer is in direct proportion to the emphasis given in instructions to the transfer effect during the training period. The transfer of attitudes (and methods) is more effective than transfer of a specific activity.

VIII. LAWS OF LEARNING

The results of the experiments on learning, with both animals and humans, have been generalized and stated as laws of learning. In 1923 Symonds listed twenty-three such laws of learning and more have been formulated since that date. Several laws relating to the conditioned reflex were stated in Chapter III. A few of the most important laws, which are generalizations of learning, are stated below.

A. Law of Exercise (Use, Frequency, Practice)

Other things being equal, the more a given stimulus-reaction connection is exercised the more frequent will be the correct reaction. Stated conversely, this law is known as the *law of disuse*. The 'other things being equal' qualification, suggests that there are other important conditions which must be fulfilled before the law will operate.

B. The Law of Effect (Thorndike)

Other things being equal, stimulus-reaction connections which are pleasant will be strengthened and those that are unpleasant will be weakened. This law bases learning upon P-U (pleasantness-unpleasantness) as a causative factor. The chief difficulty in connection with the statement of this law lies in the definition of pleasantness and unpleasantness. Investigations into P-U are reviewed in Chapter XIII.

C. The Law of Readiness (Thorndike)

In an attempt to explain the Law of Effect, the Law of Readiness has been proposed. This law is stated as follows: for a connection to respond when it is ready to respond is pleasant, for a connection not to respond when it is ready to respond is unpleasant, and *vice versa*. This substitutes 'readiness' for P-U.

D. The Law of Belongingness (Thorndike)

Other things being equal, stimulus-reaction connections which 'belong' are better learned than those which do not have 'belongingness'. By belongingness is meant a 'natural' connection between the stimulus and reaction.

E. The Laws of Primacy and Recency (Watson)

Other things being equal, the first learned acts will be better remembered than acts learned later; also, other things being equal, the last learned acts will be better remembered than acts learned earlier. These two laws seem to be contradictory. But one may apply in one case and the other in other cases due to individual differences in the learners and in the tasks.

F. The Law of Intensity (Vividness) (Carr)

Other things being equal, an intense stimulus-reaction connection will be longer remembered than a less intense connection.

IX. THEORIES OF LEARNING

There are four main questions which an adequate theory of learning must answer. How is the first correct reaction made? How are unsuccessful and unnecessary reactions eliminated? How are the correct reactions 'stamped in' or fixed? Why does the learner persist in his efforts until the learning is complete? A satisfactory theory must be consistent with experimental findings upon learning and forgetting.

A. Summary of Theories of Learning

Some of the theories formulated to explain learning, the laws upon which they are based, and leading advocates of each theory are listed below. (Some of the theories cannot be related to specifically stated laws of learning).

Theory of	*Laws*	*Advocate*
Hedonic Tone (P-U)	Effect-Exercise	Thorndike
Intensity	Effect-Intensity	Carr
Confirmation-Inhibition	Effect	Hobhouse
Congruity	Effect	Holmes
Completeness of Response	Effect	Peterson
Frequency-Recency	Frequency-Recency	Watson
Motor-Set		Woodworth, Kuo
Cue Reduction		Hollingsworth
Gestalt		Köhler, Koffka
Conditioned Reaction	Temporal Laws of the Conditioned Reaction	Smith and Guthrie

Three of the more inclusive of these theories will be considered in greater detail.

B. Hedonic (P-U) Theory

This theory accounts for the first correct reaction as a matter of chance through trial-and-error. The unsuccessful reactions are eliminated because they are 'annoying' or unpleasant and the adaptive responses are selected because they are 'satisfying' or pleasant. The adaptive reactions are 'stamped in' by exercise.

There are two objections to the theory, (1) motivation in learning is not considered and (2) causation of pleasantness and unpleasantness (P-U) is not explained.

C. Frequency-Recency Theory

This theory also accounts for the first successful reactions as due to chance. The selection of the correct reactions and elimination of the unadaptive reactions are functions of frequency. The reactions prior to the successful final response are the result of chance. As trial and error continues the successful reaction is made more frequently than any of the others. Also, since it is the last response in each series it is made more recently than other reactions.

The chief objections to the theory lie in its failure to explain motivation and perseverence of activity and in the unproved assumption that following each unadaptive reaction the learner will try another reaction and not continue to react in the same unadaptive manner.

D. Gestalt Theory

This theory considers learning as a process of growth or maturation. The first correct reaction may be due to chance, through trial-and-error in some cases, but more frequently it is the result of 'insight' into the problem. Insight accounts for the selection and elimination process. The 'stamping in' is due to exercise as each presentation of the task is a stimulus to further growth and maturation.

Insight is not exactly defined in experimental terms in this theory and motivation is neglected.

E. Summary of Theories of Learning

These theories of learning differ in their emphasis upon various generalizations and laws in explaining the total learning process. No one theory accounts for all the problems and facts of learning.

X. THE BRAIN AND THE LEARNING PROCESS

Many attempts have been made to relate the learning process to various neural mechanisms, and especially to the cerebral cortex. Earlier writers localized various psychological functions in different areas of the cortex and 'the higher psychological processes' such as learning, thinking, and reasoning, were usually allotted to the frontal lobes. Recently, experiments have tested the theories of cortical localization as relates the learning process.

A. Lashley's Experiments

Through a refined surgical technique operations are performed upon the cerebral cortex of white rats without damaging the subcortical nerve fibers. Lashley removed various segments of the cerebral cortex of rats, tested them for learning ability, and compared their performance with results for a group of control (normal) animals. Operated rats were definitely retarded in learning, making more errors and requiring more trials and longer times than the normal rats. Thus the cortex of the cerebrum is shown to function in learning. One animal with 80 per cent of the cortex removed made considerable progress in maze learning; errors were reduced from about 500 to 7 in 150 trials, but the rat was much inferior to normal animals who learned the maze in less than 25 trials. Lashley found a very high correlation (0.86) between amount of cortex removed and number of errors in maze learning. Thus amount of a functioning cortex, rather than localization, is indicated as necessary to learning. As a specific check on cortical localization of the learning function different areas were removed from different animals and all were given the same problem to learn. No differential effects on learning resulted from destruction of the different cortical areas as long as the amount destroyed was the same. The locus of the destruction was apparently unimportant, but the amount of destruction was.

B. Some Generalizations

Lashley's experiments in particular have led to a conception of learning as the function of the entire cortex and they have led to a natural skepticism of specific and localized bonds as the neurological basis of learning. That nervous integration takes place as *mass action* is the hypothesis that connections between S and R in learning involve large segments of the nervous system rather than individual neurons.

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CHAPTER VIII

EMOTION

Disintegrative Activity

Emotion is a disturbed psychological condition, which can best be described as disintegrative activity. However, emotional activity may act as a stimulus to future integrations.

I. EMOTIONAL ACTIVITY

The stimulating situation in emotion is a highly complex mass of changes which take place in the environment, in the organism, and in awareness.

A. Aspects of Emotion

Emotion is observable in three aspects of psychological activity: (1) in awareness, where sensitivities localized in the viscera are prominent and feeling (pleasantness or unpleasantness) is focal and intense, (2) in explicit reactions, where behavior is random and abortive, and (3) in implicit reactions, particularly in the viscera, where circulatory, glandular, and vegetative functions are excited and inhibited.

B. Point of View

All three aspects of emotion are susceptible to experimental investigation and emphasis upon one or the other has influenced the definition of emotion. Early work in understanding emotion was on the awareness aspect and investigations were by the method of introspection. Thus, 'emotion' was the emotional awareness: emotional reactions were 'expressions' of emotion (Darwin); glandular changes, or other implicit reactions, were 'physiological manifestations' of emotion. The emotion was defined by its conscious dimensions. This view is widely expressed in psychological writing even today.

With the development of objective methods, studies of emotional behavior have taken note of the distinguishing marks of the emotional reaction pattern and the disintegrated nature of this form of behavior. The foremost experimental interest at present is in the physiological aspect of emotion, while the criterior of emotion is still that of its awareness.

C. Definition

Emotion may be defined upon either of its three aspects.

1. As Explicit Behavior. From the explicit or behavior point of view, emotion is disintegrative behavior and takes the form of random or abortive pattern reactions, which rapidly run their course as a usual thing. These emotional pattern reactions are called by such terms as fear or anger, according to the nature of the stimulating situation. Also, these reactions may be successive in nature, as in running away from danger and in fighting. But frequently such successive reactions lose their disintegrative emotional component early in the series and become efficient successive reactions. The behavior aspect of emotion is observable most often as a disintegrative pattern reaction, or as a combination of disintegrative pattern reactions of random sort. But emotional behavior may terminate in an efficient successive reaction adjusting the organism to its environment.

2. As Implicit Reactions. From the implicit or physiological point of view, emotion is the sum of a large number of circulatory, glandular, nervous, and muscular changes, which are measured by various techniques. There are no characteristic implicit reaction patterns, in terms of the measures of any emotions, such as joy, sorrow, fear, anger, but rather is there a general physiological state, which varies in degrees and specificity of implicit reaction. In total, these implicit reactions appear disintegrative, although they contribute to integrative behavior on a higher level of efficiency after a certain time interval. In this manner they are motivating factors in behavior.

3. Awareness. Feeling (pleasantness or unpleasantness) is focal in emotional awareness and is usually intense. Sensitivities localized in the viscera and in the vaso-motor and circulatory systems flood the complex awareness, which also may include sensitivities that are localized in the environment. Emotion is a rapidly moving awareness. Recalled sensitivities, of course, are present. Emotion in awareness is again disintegrative. It has been referred to as a 'stirred-up-state of mind' (Woodworth, 1921).

D. Characteristics of Emotion

Emotion in all its aspects is (1) disintegrative and (2) dynamic psychological activity. In its awareness aspect (3) feeling (pleasant or unpleasant) is focal; in its physiological aspect the glandular reactions may be (4) motivating; in its behavior aspect reactions are (5) inefficient in adjustment.

II. THE STIMULATION OF EMOTION

The stimulating situation in emotion may be analyzed in the same manner as in any other kind of psychological activity.

A. The Environmental Stimulus of Emotion

Environmental stimuli which are sudden, unusual, and intense, such as a loud sound, a flash of light, pain, a change in support, may be an immediate cause of emotion. This is particularly evident with young children and infants, and these stimuli have been thought of as the stimuli to native emotional reactions. Environmental situations, such as dark places, high places, open places, closed places, wild places, rough looking men, animals, and so on, come, through learning, to be the important stimuli of emotion. For adults, the environmental stimuli of emotion are often words, phrases, and acts of other people, which involve dynamic awareness situations. The stimuli of emotion are predominantly social in adult life.

B. The Emotional Stimulating Situation in Awareness

Words or acts of other people, in particular, may stimulate a succession of recalled awarenesses which build up to a highly emotional awareness. The sensitivities from the environment, which are thought often to be the initial cause, are unimportant. The background of recalled sensitivities is the important cause. A chance environmental stimulus starts the emotional association processes in awareness, but in the awareness are the essential causative factors. Much of emotional activity in the adult is of this kind. An extreme illustration is the sensitive person by whom an unintentional act of another is received as a slight which is magnified until the person becomes quite depressed.

Below the surface of awareness, of course, is the *emotional set*, which has developed due to similar situations in the past. The emotional set is a special form of the mental set, causing emotional activity. Where it begins its development in the life history is not known, but it seems that early in life, somehow, awareness activity took an emotional course by chance as a possible adjustment to an environmental situation. Later activity tends to follow the same course.

An environmental stimulus initiates emotional activity, but it may have very little to do with the course of its development. An inconsequential sensitivity may stimulate an illogical sequence of recalled sensitivities, which lead to intense emotional activity, as illustrated in the person mourning a great loss who seems unable to discuss anything else. Emotional activity, at least in mature forms, is dominated by emotional sets, which can best be studied in awareness.

C. Stimulation in Glandular Activity

The glandular, circulatory, and other implicit reactions in emotion, which become stimuli of further implicit emotional reactions, are caused by those stimuli already mentioned as important stimuli of emotion. What has been said of the awareness situation in emotion may

be said of implicit reactions, and particularly of glandular activity. Adult activity is full of *emotional conditionings,* and glandular innervation takes place from causes which are far removed from those which early in life caused visceral emotional patterns. A word of another, a thought of past experience, almost anything, may cause implicit reactions characteristic of emotion. Particularly is this true of the mentally abnormal person, as in the manic-depressive psychosis.

III. EMOTIONAL REACTION

Emotion may be studied as stimulation or as reaction. Reactions, of course, become stimuli, and the pattern of stimulation is formed of many factors, including previous reactions. Emotional reactions are studied in the physiology of the organism or in its various overt patterns of behavior. The former are called implicit and the latter explicit reactions.

A. Implicit Reactions

Internal reactions, such as visceral and glandular activity, show considerable variability from person to person and from time to time in the same person under standard conditions of stimulation. There seem to be no definite emotional physiological conditions which are correlated with the stimulus or explicit behavior.

B. Explicit Reactions

External reactions (such as those of joy, sorrow, and fear) also vary widely from time to time in the same individual and from person to person. Patterns of reaction have been described for emotional behavior (Morrison, 1924) and some uniformity of emotional patterns is evident. But this uniformity is not great enough to say that a certain pattern, or parts of a pattern, of reaction always exists for a certain form of emotional behavior, such as joy or anger. In general, it may be said that emotional behavior patterns for the same emotion (introspectively described) differ more in the same individual from time to time, and between individuals, than they are alike.

C. Disintegrative Behavior

Emotional reactions, either as implicit or explicit behavior, may be viewed as distintegrative phenomena. Emotional reactions are disorganized reactions. Psychological activity, as behavior or awareness, tends to be integrated from the point of view of efficient and satisfactory adjustment to environmental situations. Emotional activity is the most disorganized form of awareness or behavior, while it may under certain conditions lead to a better adjustment due to the physiological motivation in this activity.

D. Emotional Language

An emotional language is formed of emotional reactions for histrionic expression, and is used on the stage or in social intercourse. There are no common emotional reactions, but these conventionalized 'expressions' are accepted by people generally as emotional reaction patterns. This accounts for the popular belief in uniformity of emotional reaction.

IV. THE EXPERIMENTAL INVESTIGATION OF EMOTIONAL REACTIONS

Emotional reactions are studied by the *methods of expression*.

A. Physiological Reactions in Emotion

During emotional behavior many physiological changes take place. These changes may be observed and measured in several ways.

1. Methods for Measuring Physiological Activity. Some of the techniques used to investigate the physiological activities of emotion follow:

a. Changes in pulse rate are measured by a *sphygmograph*.

b. Blood pressure is measured by a *sphygmomanometer*.

c. Breathing rates are measured by a *pneumograph*.

d. Psycho-galvanic responses are measured by a *galvanometer*.

e. Glandular activity, especially of the adrenals, is measured indirectly by urinalysis or analysis of the blood.

f. Changes in digestive activity may be studied by X-rays or by the 'balloon technique.'

g. Surgical techniques are involved in studies of certain glandular activities, as salivation, and in cutting nerves to eliminate part of the stimuli, or reactions, from the total activity.

2. Findings Concerning Physiological Reactions in Emotion. Various changes have been studied by different investigators and the following are some of the results:

a. *Changes in the Digestive Tract.* Following emotional stimuli, changes in the tonicity of the stomach occur. Sometimes tonus is increased and in other cases it is decreased. The results for any one stimulus are not consistent (Brunswick, 1924). Stomach contractions and intestinal movements are decreased or stopped completely (Cannon, 1915). Salivary and gastric secretions are reduced, and other digestive activities lessened.

b. *Glandular Secretions.* Following emotional stimuli the hydrogen-ion concentration (ph) of saliva is altered (Starr, 1922). Secretion of adrenalin is increased (Cannon, 1915, and others). In some cases activity of the sweat glands is greatly increased, as in a 'cold sweat.' Glandular activity in general is thrown out of normal balance.

c. *Cardiac Changes.* Experimenters have found that following a 'startle stimulus' pulse rate decreases, but heart beat amplitude increases (Skaggs, 1926). Emotional stimuli are followed by greater irregularity of systolic blood pressure than are non-emotional stimuli (Landis and Gullette, 1925). Expectation of an electric shock results in an increase in pulse rate (Skaggs, 1926). Volume of the hand and arm decreases due to changes in the volume of the blood vessels and capillaries. Numerous other less important cardiac changes have been reported as taking place during emotion.

d. *Respiratory Changes.* Among reports of changes in respiration are the following: a 'startle' produces a sudden catching of the breath, breathing rate increases, and breathing becomes very irregular and follows no consistent pattern (Skaggs, 1926). The inspiration-expiration ratio is lower before answering falsely to a question than after the answer has been given (Burtt).

e. *Electrical Changes* (*The Psycho-galvanic Response, P.G.R.*) Bodily resistance to the passage of a small electric current is decreased (Wells and Forbes, and others). A difference in potential between two points on the skin is correlated with the emotion (Fere, 1888; Tarchanoff, 1890). These changes seem to be correlated with hyperactivity of the sweat glands.

The results cited for physiological changes during emotion are by no means uniform, and considerable variation is found both from experiment to experiment and from subject to subject in the same experiment. There seems to be no definite physiological pattern peculiar to any specific emotion; from the physiological activities it would be impossible to name or classify the emotion.

B. Facial Reactions and Other Overt Emotional Reactions (The 'Expressions of Emotion')

Studies of emotional expressions began with Darwin (1872), who assumed that there were relatively fixed and characteristic facial expressions for various emotions. Facial expressions of emotion have been studied by motion pictures and by judgment of photographs.

1. Experimental Results. Intelligent judges fail to agree upon photographed emotional reactions of a talented dramatist, except the most common ones, such as laughter and aversion (Feleky, 1914). When photographed emotional reactions are estimated, 'primary' emo-

tions, such as love and hate, joy and sorrow, are judged more uniformly than the 'secondary' ones, such as repulsiveness, surprise, distrust, and defiance (Ruckmick, 1921).

Further judgments of photographed emotional reactions showed only 33 percent correct according to the dramatic portrayal, with laughter 64 percent and disgust and fear 36 percent correct (Langfeld, 1918). There are characteristic facial expressions of all emotions in the same individuals, but no typical expressions of emotional situations for people generally. Facial emotional expressions are determined more by the individual than by the emotional stimulus (Landis, 1924). Emotional situations traditionally thought to produce rage reactions in cattle (red colors and smell of blood) produced no such emotional reactions (Stratton).

2. Classification of Emotional Reactions. Emotional reactions are customarily named or classified as fear, joy, anger, rage, and the like. Experimental evidence shows that such names are given either on the basis of the stimuli arousing them or the conventionalized learned methods of responding to the stimuli. For instance, weeping is associated with grief, and laughter with joy or happiness. In the case of the infant's emotional behavior it has been shown that adults could not differentiate the emotions unless they had some knowledge of the stimuli arousing them (Sherman, 1927).

C. Emotional Maturity (Normal Emotional Life)

Studies of emotionality or emotional maturity are made by the use of association tests and rating scales for which norms of average reaction and deviations from average are prepared. (Rating scales and tests of emotion are discussed in Chapter IX, Personality and Adjustment.)

V. THE GENETICS OF EMOTIONAL REACTIONS

The genetic investigation of emotional reactions by experimental techniques was begun by Watson.

A. Watson's Unlearned (Inherited) Emotional Reactions

Watson (1920) concluded from his study of infants that there are three inherited emotional pattern reactions, which with their stimulating situations are as follows: (1) fear—loss of support or a loud noise, (2) love—stroking and petting, (3) rage—restraining bodily activities. Later studies by Sherman (1927) show that it is not possible to distinguish these three emotional reactions without some knowledge of the stimuli or other factors in the situation.

B. Learned (Conditioned) Emotional Reactions

Using the stimuli described by Watson and applying the general methods for conditioning reactions it has been shown that emotional reactions may become associated with stimulus objects which previously had no such emotional association. By the same technique emotions may be 'unconditioned.'

1. Watson's Conditioning Experiment with Albert. Albert was an 11 month old healthy baby living in the hospital, in whom it had been found that only loud sounds and removal of support produced fear reactions. A white rat was presented with a loud sound as an unconditioned stimulus to fear. The white rat became a conditioned stimulus to fear reactions in seven combined presentations so that instead of reaching for the rat, as he did before, Albert cried and crawled rapidly away from the conditioned stimulus. Also, a transfer of the fear reaction was made to other small animals and furry-objects, such as a rabbit and a Santa Claus mask.

2. Jones' Unconditioning Experiment with Peter (1924). Peter was a 2 year and 10 month old child who had been conditioned to fear a rabbit. The unconditioning method was positive, and a second conditioned reaction was established between the fear stimulus (the rabbit) and food after 120 combinations of the two stimuli. Each day the fear stimulus was brought closer to the child as he ate his meals and only removed when the child cried or asked that 'Bunny' be taken away. At the conclusion of the experiment Peter patted and played with the rabbit.

Jones describes Peter as a very difficult example of unconditioning. The degree of difficulty was determined by the distance the fear object needed to be away from the child and not cause avoiding reactions. In Peter's case the necessary distance was about 20 feet.

C. Adult Emotional Patterns

By the time the person has become an adult his emotional behavior is fairly well conventionalized. Facial expressions and similar overt aspects of emotion are recognizable. The emotion being exhibited may be named and classified with a higher degree of accuracy than in the case of infants.

VI. EMOTIONAL AWARENESS

Emotional awareness is described as a 'stirred-up-state' in which feeling (pleasantness or unpleasantness) is focal and it is difficult to report details in introspection (method of impression).

A. Genetics of Emotional Awareness

Emotional awareness develops over a relatively long period of time. Usually the emotional awareness reaches its greatest degree of disintegration some time after its initiation. But occasionally a strong emotion appears quite suddenly, and the person is said to have lost control. Integration in awareness is slow following intense emotion.

B. Emotional Awarenesses are Disintegrative Awarenesses

Only feeling is focal in emotional awareness. Thinking (successive awarenesses of sensitivities and recalled sensitivities) is fleeting and illogical. Emotional awarenesses are highly disintegrative awarenesses from the point of view that the function of awareness in integrated activity (thinking).

C. Introspection of Emotional Awareness

It is impossible to make a complete introspective description of an emotional awareness, but partial introspection indicates: (1) that feeling (pleasantness or unpleasantness) is focal, (2) that emotional awareness is disintegrative, (3) that sensitivities and recalled sensitivities are fleeting and vague, as far as detail is concerned, and (4) that organic sensitivities often dominate the complex causing a localization of the emotion in the viscera.

VII. THEORIES OF EMOTION

Scientific thinking about emotional activity has gone through definite stages of development which is crystalized in the three following theories.

A. The James-Lange Theory of Emotions

James (1884), in the United States, and Lange (1885), in Denmark, arrived independently at such similar conclusions that their views have been consolidated into what is generally known as the James-Lange Theory of Emotions. In this theory the emotion is the organic-kinesthetic awareness of the reaction to the original stimulus. The emotion follows the course of the original S-I-R activity; the implicit and explicit reactions to the stimulating situation are stimuli which affect proprio- and interoceptors and give the 'stirred-up-ness' of the emotional awareness. The order of activity is considered to be somewhat as follows: (1) the emotional exciting situation, (2) the physiological reactions, in particular, and the explicit behavior, (3) the awareness of physiological changes, in particular, and other movements of the body. James emphasized the visceral elements while Lange placed emphasis on the activity of the vaso-motor system. In this theory the order of the elements of the complete reaction are (using a classical illustration), seeing a bear—running—emotional awareness (emotion).

The James-Lange Theory resulted from the separation of emotion, as mental, and behavior, as physical, by the 'mind-body' philosophy. In this theory there is interaction of the physical, organic reactions, upon the mental, emotional awareness. The physical reactions cause the mental phenomenon which is the emotion.

B. McDougall's Aspect Theory of Instinct and Emotion (1908)

McDougall states that emotion, as a conscious state, and instinct, as inherited reaction, are two aspects of the same activity. He listed fourteen combinations of emotions and instincts, such as: (1) instinct to escape—fear emotion, (2) instinct to combat—anger emotion.

McDougall's Theory is also the product of a 'mind-body' philosophy, which separated emotion, as mental activity, and instinct, as physical activity. Most writers on psychology during the latter half of the 19th century evolved theories relating instinct and emotion, and McDougall made them two aspects of the same existence.

C. Cannon's Central Theory (1927)

Cannon's researches in the physiology of emotion have led him to the conclusion that a center of emotion exists in the thalamus, which, when excited, causes emotional activity in all its aspects (in awareness, in explicit and implicit reactions). The theory explains that, upon excitation of the thalamus, nervous discharge passes to all parts of the nervous system, including the cortex. Thus various emotional activities are stimulated simultaneously. A similar theory was proposed by Dana (1921).

Cannon's Theory has an historical precursor in Descartes' theory of the pineal gland as the seat of the soul. But his theory is the product of experimental work, contradicting the James-Lange Theory, in which the elimination of the action of interoceptors failed to remove the emotional reactions in animals. As genetically older parts of the brain were removed, beginning with the fore-brain, there was no change in the emotional pattern in animals, until the thalamus was removed, after which all emotional behavior ceased.

Each of the above theories was developed to clarify a certain point of view in psychology and all have served their purpose. But none of them, or any of the many others which have been formulated, satisfy all the known conditions of emotional activity.

VIII. EMOTION AS MOTIVATION

The experimental emphasis in the study of emotions has become physiological, and physiological psychologists think of emotion as glandular stimulation and as belonging to that large class of organic or physiological drives, such as hunger, fatigue, and sex. Woodworth

(1921) calls attention to the close relation of the organic states and emotion. He discusses them as driving stimuli and many authors, today, treat of emotions as purely organic stimuli in the final integration of behavior.

IX. PERSONALITY QUALITIES (Feeling, Temperament, Affective Activity)

Moods, attitudes, interests, passions, sentiments, the psychoanalytical 'complex,' etc., are personality qualities (traits) in which the disintegrative activity of emotion may be present in various degrees.

A. Moods

Emotional activity may terminate in a mood and the mood may be a fairly permanent emotional set throughout life. The mood acts as a stimulating situation for further similar moods.

B. The Complex

Psychoanalysis studies mood (emotional set) as a 'complex.' The psychoanalyst endeavors to unravel the history of the development of the complex so that the patient may become aware of the initial causes. Awareness of the causes was regarded by early psychoanalysts as constituting a cure but now it is considered as only one of many factors in the adjustment process.

C. Attitudes, Sentiments, Interests

Attitudes, sentiments, and interests are feeling activities (pleasantness and unpleasantness) in which emotion is present in degrees and the emotional set is the essential cause. The emotional set gives these activities their varying degrees of permanence. In interests the emotional set is at a minimum and in attitude, under certain conditions, emotional activity may dominate the situation. Psychologists in England prefer the term 'sentiment' for these activities, while psychologists in the United States use the term 'attitude' for those with stronger and 'interest' for those with weaker emotional components. Interests and attitudes have been subjected to measurement (see Chapter IX) and are discussed as feeling activity (see Chapter XIII).

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CHAPTER IX

PERSONALITY AND ADJUSTMENT

We commonly speak of a person as possessing personality, or that one individual has a good personality and another a poor personality. Differences in personality are thus indicated. The psychologist describes and measures the qualities (traits) of personality, and compares his measurements with the adjustment of the individual.

I. DEFINITION

By personality is meant the sum-total of observable reactions of an organism. This definition would include general intelligence as a quality of personality. But personality is defined usually as all qualities other than intelligence.

Personality has three distinct measurable aspects, as follows: (1) *physique*—the contributions of the physical structure, (2) *chemique*—the contributions of the glands and other physiological activities, and (3) *psychique*—the contributions of behavior and awareness activities, such as in emotion, attitude, and feeling. These are the three aspects of the total personality.

II. OBSERVATION AND MEASUREMENT OF PERSONALITY

Until almost the last decade knowledge of personality and the differences between people in personality traits was derived wholly from general observation. The classification of mental disorder (mental disease) or abnormalities of personality, was gained through general observation of clinical symptoms. The qualities of personality have been most difficult to define and measure. Measurements are made by three standard techniques: tests, rating scales, and inventories. When personality qualities are subjected to measurement they are called traits.

A. Tests

Personality tests, like intelligence tests, are carefully standardized experiments, useful only when applied by an expert. They differ from tests of intelligence in content and sometimes in form, but are prepared and administered in much the same manner.

B. Rating Scales

The items of rating scales do not call for specific facts as do tests, and other persons make the ratings based upon their observations of the subject being rated. A rater (judge) may be asked to rate several people for honesty by numbering the most honest person as 1, the next as 2, and so on. He may be asked to rate some one person on several different traits, as honesty, personal appearance, and emotional maturity. Often this is done by checking on a line of degrees or percents. One end of the line is designated as absolute honesty and the other end as absolute dishonesty.

C. Inventories

An inventory is a self-rating scale. The inventory usually includes a large number of specific items for self-rating in degrees and is scored according to the responses of a normal group of people.

III. PHYSIQUE

The physical characteristics contribute to the total personality and are designated as *physique*. Tests are available for the measurement of both anatomical structures and physical capacities.

A. Measures of Structure

Measures are made of height, weight, cranial capacity, cranial shape, body size, body build, and facial angles, and numerous indices are derived from these measures. Cranial measures are made by the use of calipers or more elaborate instruments. Hull has devised an instrument for the measurement of facial and cranial angles. Cranial measures are of particular interest because of their relation to the claims of phrenology and other character analysis systems. Definitions of 'personality types' are often in terms of body measures and physical symptoms of the abnormal personality are distinguished in diagnosis of mental disorder.

B. Physical Capacities

Measures of physical capacities are illustrated by *tests of strength* (strength of grip on the dynamometer) and *tests of vital capacity* (lung capacity by the wet spirometer). Rogers (1925) assembled a battery of seven tests of general physical capacity, consisting of right and left hand grip, strength of back and legs, 'push ups', 'pull ups', and lung capacity. Indices of height and weight were included.

IV. CHEMIQUE

Woodworth has designated the glandular and other physiological contributions to personality as *chemique*. The influence of glandular excesses or deficiencies upon the reactions of the individual are being

studied experimentally by physiological techniques and relationships established with psychological traits.

An excess of insulin causes fatigue, nervousness, and anxiety. Deficiencies of thyroxin, in addition to being related to mental deficiency in children, cause sluggishness and a decrease in physical vigor. An excess of thyroxin may, however, cause restlessness, nervousness, irritability, and general hyperactivity. The adrenal glands are related to cardiac activity, and increased secretion of adrenalin is characteristic of emotional activity. Pituitary activity influences growth. Non-reproductive (internal) secretions of the sex glands are responsible for the development of masculinity and femininity and may thus exert a powerful influence on the personality.

The endocrines are so interrelated in function that any condition tending to change the function of one is also manifest in the numerous functions of the others. Thus apparently trivial changes in a single organ may be responsible for marked changes in the personality. Since the endocrines are ductless glands secreting directly into the blood stream, the circulatory system has often been called the chemical integrator of the body. It might be designated as the chemical integrator of the personality.

V. PSYCHIQUE

"No neurosis without a psychosis" is axiomatic in the study of personality. Any physical disease has its disturbed psychological condition and organic mental disorders are characterized by distinctive psychological changes. Personality is the sum-total of reactions including physique, chemique and psychique. But interest in the study of personality has always centered in its psychological aspect.

The study of the psychological traits (symptoms) of personality has followed two definite lines of development: (1) general observation with special reference to classifications of the symptoms and diagnosis of abnormal personality (mental disorder, mental disease), and (2) measurement of personality traits with special reference to the establishment of tests for the indication of degrees of personality differences among people generally. The classification of abnormal personality has resulted from general observation and diagnosis of mental disorder, with indications of borderline symptoms of abnormality in people generally regarded as normal. The measurement of personality traits has resulted in numerous standard measures of personality, such as emotional maturity, social adjustment, character and moral conduct, interests, attitudes, mental hygiene, introversion-extroversion, ascendence-submission, and specific traits, such as the various sensitivities and skills, where there are indirect influences upon the total personality.

VI. SPECIFIC PSYCHOLOGICAL TRAITS

The influence on the total personality of specific psychological traits, such as visual acuity, are not apparent to the casual investigator. Defective vision may cause one to fail the test for an automobile driver's license. This failure and others like it may in turn cause a general feeling of inferiority for which the individual will compensate with various abnormal symptoms, such as aggressive and obnoxious behavior.

Measurement of the specific psychological traits are described here as (1) tests of sensitivities, (2) tests of motor capacities and skills, and (3) tests of the perceptual and abstract processes.

A. Tests of Sensitivities

Tests are used to determine sensory acuity and the range of sensitivities. They are useful in detecting abnormalities and in the analysis of the departments of sensitivity used in any activity.

1. Vision. Among the early tests of visual acuity were the Snellen Charts, consisting of rows of letters to be read at varying distances. A more recent test of visual acuity, the McCallie Test (1908), is a series of cards which may be shuffled and presented in different orders. Each card contains four letters of different sizes to be read at various distances. McCallie has also devised a set of cards for illiterates, using animal figures instead of letters.

Tests of color vision include, among others, the Holmgren wools and the Ishihara plates. The Ishihara Test is a series of circles made of small colored dots forming figures of different colors. The dots are of equal brightness and saturation, and differ only in hue. Color-blind persons may distinguish figures by brightness, but will fail to name the figures made by the different hues.

2. Audition. Tests of hearing include the watch-tick-test, the whispered-word-test, and instrument tests. Watch ticks and whispers vary in loudness for different testers and measures secured by these devices are inaccurate. More desirable tests are the acumeter, Seashore's Audiometer, or some similar device for standardizing the stimulus and the conditions under which the test is taken.

3. Other Sensitivities. Among other sensitivity tests are measures for the threshold of pain, pressure, warmth, cold, and two-point discrimination.

B. Tests of Motor Capacities and Skills

Single tests of motor skill measure speed or accuracy of tapping, speed or accuracy of tracing, steadiness, balancing, etc. All of these measure sensitivity as well as coordination of reaction. In addition to the single motor tests, batteries of tests have been devised by Garfiel (1923) and R. H. Seashore (1928), among others. Seashore's battery

is composed of six tests: (1) Koerth's pursuit-meter, measuring ability to follow a small target moving in a circle, (2) a motor rhythm test, which consists of tapping in time with a telegraph sounder, (3) Miles' motility rotor, measuring speed of turning a small hand drill, (4) a tapping test, (5) a spool packing test, (6) serial discriminator, measuring finger coordination in reacting to a series of visual stimuli. The score on the battery represents 'general motor skill.'

C. Test of Perception and Abstract Processes

Tests of this kind measure the span of perception, span of memory, cancellation of certain letters (or numbers) from pages of pied type, card sorting, perception of form and spatial relations, substitution of symbols for letters, rote memory, and associations. Various pieces of apparatus are used for the presentation of symbolic materials in the measurement of these perceptual and abstract processes, such as, the *tachistoscope,* which automatically exposes visual forms for a time interval limited often to a fraction of a second, the *chronoscope* which measures the time of associations in *milliseconds* (thousandth of a second, or *sigma*), and the form boards and mazes which control spatial relations in both tactual and visual sensitivities.

VII. PERSONALITY TRAITS

A large number of objective tests, rating scales, and inventories have been devised for measuring the psychological traits of personality. They include measures of psychological activity often designated by such terms as emotionality, temperament, affectivity, mental adjustment, social behavior, complexes, introversion-extroversion, dominance and submission, self-sufficiency, and disposition. The chief result of early experimentation with personality tests was the detection of atypical or potentially abnormal personalities. Personality tests are classified into ten fields for measurement, as follows: (1) emotional stability, (2) emotional maturity, (3) extreme affectivities, (4) emotional complexes, (5) introversion-extroversion, (6) temperament, (7) social behavior, (8) interests and attitudes, (9) character and conduct, (10) personality batteries.

A. Emotional Stability

Woodworth (1917) devised the first inventory for measuring psychoneurotic tendencies (instability) and emotional maladjustment. Questions relating to the emotional habits, complexes, and likes and dislikes of the subject were designed to indicate possibilities of future emotional maladjustment. The Woodworth Psychoneurotic Inventory, which was used in the U. S. Army during the World War, has been revised by Mathews (1923), House (1927), and others, and tests using the same or similar material were developed by Laird (1925), Chassell (1928), Thurstone (1929), and Bernreuter (1932). The Thurstone Inventory

(called the Personality Schedule) consists of 223 questions which the subject answers by encircling either 'yes,' 'no,' or '?.' The '?' indicates inability to answer. Scoring is in terms of 'maladjusted answers' and a high score on the test may indicate emotional instability. While not all high scoring individuals are unstable, all the unstable individuals will be found in the high scoring group.

This inventory discriminates satisfactorily between groups of people known to be emotionally stable (college students) and groups known to be unstable (inmates of a hospital for the insane). There is a slight relationship between college scholarship and emotional instability but no relationship between intelligence and instability. Women are more unstable than men in terms of scores on the inventory (Thurstone, 1929).

B. Emotional Maturity

The Willoughby E-M Scale (1931), composed of 60 descriptions of emotional situations, is prepared as a scale of emotional maturity or development. Following each statement various ways of reacting in the situation are indicated for choice by the person making the rating. The total score on this scale indicates the degree of emotional maturity.

C. Extreme Affectivities (Likes and Dislikes)

The Pressey X-O Series (1920) is a measure of likes and dislikes composed of several lists of words (600 in all). The subject crosses out words which are unpleasant, or disliked, and encircles those which are most unpleasant. There are two scores, one of which is a measure of 'general affectivity' and the other of 'personal idiosyncracy.' The former is the total number of disliked words and the latter is the extent to which the subject agrees with others. Scores in this test are related to scholarship in college and in a lesser degree to general abstract intelligence. They are related also to emotional maturity (Chambers, 1928).

D. Emotional Complexes

Association tests are used to discover emotional complexes (emotional set, extreme affectivity). The Kent-Rosanoff Association Test (1910) is a list of one hundred stimulus words to which the subject responds by speaking or writing the first word he thinks of after each word is pronounced. The replies of each subject are compared with the replies given by 1000 normal persons and agreements or disagreements are noted. The disagreements (peculiar associations) may indicate complexes. There are many methods of using and scoring association tests.

Association tests are used in the detection of guilt and deceit (Burtt, and others), in studies of delinquents (Mateer), as a masculinity-femininity test (Wyatt), as designating fields of interest (Wyman), and in the psychoanalytic study of the unconscious.

E. Introversion-Extroversion

Personality is measured as an introvert-extrovert continuum by several well known tests. Conklin (1923), Laird (1925), Marston (1925), Heidbreder (1927), and Neymann and Kohlstedt (1928) have developed inventories for measuring personality in these terms. The replies to the questions of The Neymann-Kohlstedt Test indicate the 'shut-in,' 'self-sufficient,' introverted personality or the contrasting extroversion. Introversion is closely related to emotional instability and neurotic tendencies (Bernreuter, 1931).

F. Temperament

The best known tests of temperament are the Downey Individual Will-Temperament Test (1922) and the Downey Group Test of Will Temperament (1922). These tests are based on handwriting reactions and measure responsiveness to changing conditions of motivation. Scores on the tests indicate speed of activity, aggressiveness, willfulness, tenacity, etc. The validity and reliability of tests of temperament have not been satisfactorily established.

G. Social Behavior

Tests of social behavior measure knowledge of social conduct and facility in adapting to environmental conditions or social groups. Such tests are in the experimental stage of their development, but one of these tests, The George Washington Social Intelligence Test (Moss, et al., 1927) has been widely used as a test of general social intelligence comparable to abstract intelligence tests in the measurement of a unitary field of intelligence. This test is described in Chapter VI.

The Morris Trait Index: "L" (1932) is a measure of leadership in the specialized field of professional education. It discriminates fairly well between recognized leaders and non-leaders. Allport and Allport (1928) developed a Scale for Measuring Ascendance—Submission in Personality. This inventory is composed of 33 problem situations designed to indicate the extent to which one dominates others or is dominated by them.

H. Interests and Attitudes

Tests of interests and attitudes measure similar psychological activities. Their chief distinction is in their aim and method of measurement.

1. Interests. Most interest measures are personal inventories. *S* indicates his likes and dislikes by appropriate markings of words or phrases. Measures of interest reactions are tests of information of objects and activities. Special interest inventories and tests are available for vocational, educational, recreational, literary, and other fields of activity. The distinguishing interests of standard social groups, such as doctors, gas station attendants, ministers, technical high school students, and

so on, are determined by comparison of group interests with those of the general population. Inventoried interests indicate the specialized fields of interest (feeling) development or lack of development.

The Vocational Interest Blank (Strong, 1927) is a general interest inventory, which secures preferences for occupations, recreations, educational fields, types of people, careers, personal activities, etc. Scoring is done by comparing the responses of any one person with the responses of standard social groups. Scoring scales for approximately 30 occupations are available for use with the Strong Vocational Interest Blank. Other interest measures include The Vocational Interest Test for College Women (McHale, 1922), The Occupational Interest Blank for Women (Manson, 1931), The Interest Questionnaire for High School Students (Garretson and Symonds, 1931), The Vocational Interest Quotient Blank (Hepner, 1931) and the Vocational Interest Inventory (Thurstone, 1936).

2. Attitudes. Inventories of opinions upon various social, moral, religious, political, and other issues, determine the range of these specific attitudes for a normal population. Individuals are rated for intensity of these attitudes. In most of the attitude inventories, statements are made, such as "The United States should immediately join the League of Nations and the World Court." *S* indicates his attitude towards the statement by marking 'agreement,' 'doubtful,' or 'disagreement.'

Well known attitude scales are the Test of Public Opinion (Watson, 1923), and the series of approximately forty scales prepared by Thurstone and his colleagues measuring attitude toward God, birth control, war, internationalism, the Chinese, prohibition, capital punishment, the Negro, etc. Remmers (1933) has constructed general attitude scales for measuring attitudes toward any social institution, any political party, etc.

Attitudes toward any given issue vary with geographical area, education, socio-economic status, etc., (Thurstone). Children's attitudes towards Germans and Chinese changed significantly after seeing pro-German and pro-Chinese movies and the changes were quite permanent (Thurstone and Peterson, 1932). Workers' attitudes toward their company was positively related to success on the job (Uhrbrock, 1933). College students whose attitudes are liberal on one issue are liberal in general and liberalism is positively related to success in college (Likert, 1934).

I. Character and Conduct

Tests of moral conduct are in the experimental stages of development. Numerous experimental programs have set up procedures for the measurement of conduct and the value of this measurement is evident in its application in education and the retraining of anti-social persons. The Character Education Inquiry, directed by Hartshorne and May

(1928), illustrates the attempt to establish measures of conduct. It prepared and used tests for measuring honesty, trustworthiness, cheating, stealing, lying, persistence, cooperation, and the like. For example, cheating was measured by comparing the score reported by a subject, who scored his own test, with the actual score, secured by the examiner unknown to the subject. Other tests measure knowledge of moral principles, such as Kohs Ethical Discrimination Test (1922), and attitudes toward moral issues, such as Grossman's Judgment Speed and Accuracy Test (1928).

J. Personality Batteries

Several batteries of personality tests have been prepared for the measurement of larger units of psychological activity. Among them are Laird's Colgate Mental Hygiene Series (1925) and Bernreuter's Personality Inventory (1931). Bernreuter's test is a measure of four aspects of personality: psychoneurotic tendency, self-sufficiency, introversion-extroversion, and dominance-submission. The test is composed of questions and *S* reacts by marking 'yes' 'no' or '?,' as in the Thurstone Personality Schedule. The differentiation of the four measurements is obtained by scoring with different answer keys.

VIII. THE ABNORMAL PERSONALITY

In the investigation of the abnormal personality, testing is impossible often, because the extremely abnormal person will not or cannot cooperate in tests. Descriptive symptoms or categories of traits are used to classify the abnormal personality into kinds of mental disorder.

A. Classification of Abnormal Personality (mental disorder, mental disease, legal term: insanity)

Mental disorders are classified as: (1) the *organic*, which are associated with a definite physical or chemical injury that is essentially causative of the disorder, and (2) the *functional*, which are psychogenic. The final causes of the functional disorders are traced in the educational (training) history of the individual, although organic changes accompany the development of the disorder and a hereditary predisposition probably exists.

1. The Organic Psychoses. All physical diseases are accompanied by some mental disturbance, and the following mental disorders are characterized by definite injury to nervous tissue: (1) general paralysis (paresis), caused by syphilis of the nervous system, (2) traumatic disorders, accompanied by delirium or loss of memory, (3) senile psychosis, the psychosis of old age, (4) arteriosclerotic psychosis, the psychosis caused by a hardening of the arteries, (5) psychoses of brain diseases, such as, tuberculosis of the brain, Huntington's chorea, brain tumor, brain syphilis, congenital brain injury, etc. Chemical or toxic injury may

cause mental disorder, as in pathological intoxication, delirium tremens, and other alcoholic psychoses, and the drug psychoses of accidental, trade, food, or habit origin. The symptoms of the organic psychoses are abnormal developments of the individual's original personality qualities, which the organic injury has let loose.

2. The Functional Psychoses. Mental disorders, which are explainable only in psychological terms are classified into the *psychoses* and the *neuroses*.

a. *The Psychoses.* The psychoses are marked mental disorders in which the normal personality of the individual is completely lost. Disintegration of personality qualities is complete. The person is disoriented in his environment.

The manic-depressive psychoses, paranoia, and dementia-precox belong to this group. The distinguishing symptoms of the manic-depressive psychoses are psycho-motor elation and depression, often with a circulatory course. Paranoia is characterized by weakness of judgment and systematized delusions. Dementia-precox shows progressively marked deterioration of intelligence accompanied by emotional disturbances, such as excitement, depression, delusions, stupor, loss of motive, and various other symptoms. It is the largest group of disorders, including more than half of the patients of state hospitals.

b. *The Neuroses.* The neuroses are conditions of 'nervousness' of apparently well people. They include neurasthenia, psychasthenia, and hysteria, which have as their symptoms various phobias or fears, obsessions, complexes, mental and physical weakness, tics and psychological paralysis. The underlying psychological condition in neurosis is a conflict between goals of action.

3. Official Classification. The official classification of the American Psychiatric Association, which is widely used in mental disease hospitals, includes the following major clinical categories of mental disorder: (1) Traumatic psychoses, (2) Senile psychoses, (3) Psychoses with arteriosclerosis, (4) General Paralysis, (5) Psychoses with cerebral syphilis, (6) Psychoses with Huntington's chorea, (7) Psychoses with brain tumor, (8) Psychoses with other brain and nervous diseases, (9) Alcoholic psychoses, (10) Psychoses due to drugs and other exogenous toxins, (11) Psychoses with pellagra, (12) Psychoses with other somatic diseases, (13) Manic-depressive psychoses, (14) Involution melancholia, (15) Dementia precox, (16) Paranoia or paranoid condition, (17) Epileptic psychoses, (18) Psycho-neuroses and neuroses, (19) Psychoses with psychopathic personality, (20) Psychoses with mental deficiency, (21) Undiagnosed psychoses, (22) Without psychoses. The latter class is included for patients with epilepsy, alcoholism, drug addiction, psychopathic personality, mental deficiency, etc., confined to mental disease institutions.

B. Causes of Mental Disorder

Mental disorder is attributed, first, to inherited predispositions, or general susceptibility to disease, second, to individual conditioning factors, such as age, physiological epochs, and sex, and third, to environmental conditioning factors, such as climate, civilization, trauma, infection, exhaustion, fright and worry. These three sets of causes operate together, of course; a predisposed person may avoid mental disease by not being subjected to a stressful environment, and the proper conditioning factors of life may cause a less predisposed person to show mental disorder.

Specific mental disorders are not inherited. Inheritance of mental disease lies in a general predisposition, or physical and mental weakness, which results in various forms of diseases, if given the proper conditioning factors. This explains why mental disorder runs in families. Mental disorders of some sort are found in the families of about 65 per cent of cases of mental disorder according to White (1924).

C. Prevalence of Mental Disorder

Patients in mental disease hospitals in the United States in 1923 totaled 265,829, or more than 225 per 100,000 of the population. Of these, 41,590 were diagnosed as of organic origin. Classified as dementia precox were 114,240 patients and as manic-depressive psychosis, 40,751 patients (Pollock, 1925). Based on a study of admissions to mental disease hospitals in New York State, Pollock and Malzberg (1928) estimate that 4.5 per cent of those born at any one time, or one person in 22, become patients in a mental disease hospital during the lifetime of his generation. These figures give one a picture of the prevalence of disorders of personality.

A high percentage of admissions stay in mental disease hospitals for the duration of their life. The recovery rate for all mental diseases is 13.6 per cent, which runs as high as 35.4 per cent for manic-depressive psychoses and as low as 6.4 per cent for dementia precox patients (Pollock, 1925). There are more beds in mental disease hospitals than in hospitals for physical disorders and more patients with mental disorders than the combined residents of feebleminded institutions, states prisons, and reformatories. The abnormal personality, with its accompanying maladjustment, is a tremendous social problem and adequate psychological measures for diagnosis, adequate methods of treatment, and adequate means of care, are yet to be devised.

D. Descriptive Symptoms of the Abnormal Personality

The most characteristic descriptive symptom of the abnormal personality is inability to fit into social organization or to adjust to the customary ways of living. This symptom is evident in the slight eccentricities of the normal person as well as in the definitely unsocial behavior of the hobo, the criminal, and the insane.

Among the specific abnormal symptoms, which may be indicated by tests or in interview, are changes, or differences from the normal, in visual, auditory, and organic sensitivities. Illusions and hallucinations are prominent in the abnormal personality. Hallucinations are false perceptions. 'Voices' of good or evil, from Heaven or Hell, are common hallucinations and 'visions' are told by the abnormal person as if they were real experiences. Delusions generally accompany hallucinations. They are false beliefs. Delusions of reference, persecution, and grandeur occur in certain mental disorders and in some they are systematized to include all of awareness. Thought is completely disoriented from reality in the systematized delusion.

Fixed ideas, obsessions, or the overweighting of an idea, doubts and phobias, such as the fear of dirt (misophobia), the fear of open and closed places (agoraphobia and claustrophobia) and the fear of fire (pyrophobia) are common symptoms among certain mental disorders. Lady Macbeth's performance in the sleepwalking scene is an example of an obsession. The normal person frequently has mild obsessions that he will have a disease, fall off a cliff, or find some one under the bed. Abnormality is a matter of degrees.

The stereotyped action carries the abnormal development of the obsession a little further and one act may be performed throughout the whole day. In somnambulism the patient lives through a painful experience which he has forgotten, although he may appear very much like the ordinary sleepwalker.

A 'flight of ideas' and retardation of thought are abnormal symptoms, and dilapidation of thought is characteristic of dementia precox. Impulsions, as in kleptomania, negativisms, exaltation and depression, increased and decreased psycho-motor activity, melancholia and stupor, amnesia, hyperamnesia and paramnesia of memory, multiple personality, emotional complexes, loss of motivation and interest, exaggerated symbolism in day and night dreaming, does not exhaust the list of symptoms of the abnormal personality.

The whole personality is affected in mental disorder. Physical and glandular changes take place. Clinical tests show disturbances of the major reflexes, such as the knee-jerk, eye reflex, Babinski reflex, and indicate destruction of nervous tissue. Personality and intelligence tests show degrees of psychological changes. The genetic history of an abnormal personality may show a symptomatology of personality differences which classifies him as one of the various mental disorders. These symptoms are but exaggerated traits of the normal personality.

IX. THEORIES OF PERSONALITY

There is no inclusive theory which relates all of the facts of personality. It would not be expected that a field of activity as inexactly defined as personality could have a complete and satisfactory theory.

But there are numerous explanations which emphasize particular aspects of personality. Some are based upon personality measurement and some on general observation. Many interesting theories are the result of clinical diagnosis of the abnormal personality. In almost all theories, personality is described as a unitary function, although the activity of different qualities of personality may be emphasized.

The oldest known theory of personality is a classification of temperaments formulated by the Greeks. About 400 B.C. Hypocrates laid the foundation for the doctrine of temperaments based on the humors (fluids) of the body and the Greek physician, Galen (167 A.D.), elaborated this theory, as follows:

Temperaments	*Humors*
Quick—strong (choleric)	Yellow bile
Quick—weak (sanguine)	Blood
Slow—strong (melancholic)	Black bile
Slow—weak (phlegmatic)	Phelgm

An exact balance of these four humors was said to make the correctly constituted personality. This classification has been extended on the psychological side by numerous investigators, such as Wundt, Ebbinghaus, Heyman, Ach, Meumann, during the latter half of the last century.

A. Theories of Physique and Chemique

Numerous anatomical theories have been developed as a basis of classification of personality qualities. A popular theory of doubtful value classifies Europeans according to racial origin into the 'Alpine,' the 'Mediterranean,' and the 'Nordic.' Four body types: the 'respiratory,' the 'digestive,' the 'muscular' and the 'nervous,' have been described by French anthropologists in relation to mental activity. Personality has been classified according to head shape (brachycephalic and dolichocephalic) and according to hair shape (flat, oval, and round). Lombroso described certain criminal types based upon measurement of physical traits, which subsequently he reported as unsupported. None of these theories are regarded as other than interesting speculations into the physical basis of personality.

Kretchmer (1925) describes four types of personality, based upon physique: the 'pyknik' (short limbed, round bodied, stocky), the 'asthenic' (long limbed, long bodied, slender, angular), the 'athletic,' and the 'hypoplastic' (underdeveloped). The pyknik personality is characterized by likelihood of reversion to extreme emotional reactions (extreme mania or depression). The asthenic is a daydreamer who withdraws from social contacts and becomes shut off from reality. The hypoplastic is likely to develop 'inferiority complexes' due to his underdevelopment, but the athletic is the nearly perfect individual. Kretchmer's theory was derived from clinical observations but subsequent measurements of actual people do not confirm his theory (Garvey, 1933).

Similarly, when actual measurements are made, the claims of various psuedo-scientific systems of character analysis, such as phrenology and physiognomy, are not substantiated (Hull, 1928; Paterson, 1930; and others).

Chemical explanations of personality have been confined largely to specific personality qualities. Various personality differences are linked to the functioning of the endocrine glands and definite correlations have been established between glandular activity and the personality qualities. No adequate chemical explanation of the total personality exists. But it is a generally accepted theory that the whole anatomy and physiology of the organism (physique and chemique) are related in what is termed the total personality.

B. Theories of Psychique

Several representative contemporary psychological theories of personality follow.

1. The Behavior Theory of Watson (1924). Personality is a development of conditioned reactions. Abnormal and normal attitudes and reactions are due to adaptive and non-adaptive conditioning of objects, activities, and persons of the environment.

2. The Psychoanalytical Theory of Freud (1883). The motivation of life is the *libido,* which is sexual energy undifferentiated from hunger at birth (sex and foot-getting instincts). Libido striving is pleasure seeking and avoidance of pain (pleasure-pain principle), which comes into *conflict* with social custom (gregarious instinct) leading to a recognition of *reality* (reality principle) and adjustment in various ways. Repression of the primitive pleasure-pain impulses may force them into the unconscious and cause a 'flight from reality' into neuroses or psychoses. Conflict between libido striving and reality determines the development of personality in an abnormal or normal direction.

3. Adler's Theory of Psychic Compensation (1917). At the foundation of this theory is the doctrine of *minderwertigkeit,* or organic and psychic inferiority. According to Adler, before birth at some time all organs of the body strive independently for nutrition. At birth they begin to function together according to the laws of compensation. Psychic inferiority has its basis in organic inferiority and mind is the instrument by which compensation for organic defects, such as in vision and audition, are accomplished. When compensation is difficult the person does not take a 'flight from reality' (Freud), but he builds up an avoidance in the face of reality (*Sicherungtendenz*). There is a *life plan* with avoiding tendencies and *rationalizations* of activity. All life begins with the *feeling of inferiority* and the measure of adjustment is the degree and kind of compensation effected.

4. TYPE THEORIES OF PERSONALITY. The ambivalent classification of personality into opposing types has interested philosophers and psychologists since the dawn of history. Plato spoke of 'shallow' and 'deep' kinds of men. 'Abstract' and 'concrete' thinkers is an early distinction which has formed the basis of intelligence measurement. Meumann (1911) distinguished between the 'statists,' who desire to leave things as they are, and the 'dynamists' who wish for active experience. Stern (1922) speaks of the 'spontaneous' and 'merely reactive' and in his discussions of testimony he classifies people according to attitude into 'subjective' and 'objective' types. One might add numerous similar opposite types of personality, which have been observed and reported, such as James' 'tough and tender minded,' Astwald's 'romanticists and classicists,' Nietzsche's 'apolonians and dionysians,' Shiller's 'naive and sentimental,' Fink's 'active and passive' and so on, but all have about the same meaning. Many of these 'types' of personality have served to *stimulate description and measurement of distinctive personality qualities.*

a. *Introvert-Extrovert Type Theory of Jung* (1903). In this theory all persons are classified into the 'extrovert and introvert' personality. Libido, according to Jung, is defined as psychic energy. In the extrovert, psychic energy is directed outward toward objects, activities, and people. In the introvert, it is directed inward in phantasy, daydreaming and thoughts about oneself.

Measurement on an introversion-extroversion continuum has led to a consideration of the trait as normally distributed among people generally with few people scattered toward the extremes of the introversion-extroversion scale.

b. *The Eidetic Type Theory of Jaensch* (1928). Included in the eidetic imagery types are people whose imagery is extremely vivid. The T-type has persisting and disturbing images and a tendency to high tonus and irritability, which are accompanied by chemical disturbances of the parathyroid. The B-type has exceptionally clear images, but directed at will, which are accompanied by over-activity of the thyroid.

C. Hall's Observational Qualities of Personality

The most inclusive theory of personality is given by G. Stanley Hall (1923) in which eight observational qualities of personality are mentioned as follows:

(1) Health, which has an observational scale value at death of 0, 100 as the apex of condition, with few living higher than 70, 80, and 90.

(2) Second breath, or mental exaltation and inspiration, akin to second breath of the athlete, of which there are many degrees of control and use of emotional energy.

(3) Free mobility up and down the pleasure-pain scale, in which some remain in an abnormal elation or depression, some split if the extreme is too long continued, and others have elasticity in degrees to experience all extremes of feeling and not be dominated by them.

(4) Sympathy, the quality of feeling with others, with degrees of selfishness and unselfishness.

(5) Love of Nature, a quality of personality expressing development in understanding of life.

(6) Sublimation, the spiritualization of animal tendencies, or the substitution of socially desirable activities for those less desirable and the use of all tendencies, such as, fear, anger, and love, with various degrees of perfection of adjustment in the trait.

(7) Activity-passivity, which includes the ambivalent distinctions of personality, such as the objectivist-subjectivist and the introvert-extrovert qualities.

(8) Loyalty, which is the subordination of the self to authority, including the idea of conscience, of which there are many degrees.

D. Summary

Personality is acknowledged as the most important field of study in psychology from the point of view of adjustment to the environment. Hall's theory of observable personality qualities suggests many traits yet to be observed and measured. Other theories emphasize important qualities in personality. No theory is satisfactory as an explanation of the total personality. But all of the theories deal with personality as a unit. which is measured in the adjustment made by the individual to his environment.

X. PERSONALITY AND INTELLIGENCE

The differences from individual to individual, and from group to group, are quite as great among the various personality traits as in general intelligence. The same normal distribution of measures exists. The overlapping of distributions, plotted for different social groups, is usual. Extremes of distributions of intelligence and personality traits alike show marked inferior adjustment to the environmental conditions of life in the lower ranges and marked superior adjustment in the higher ranges. Feeblemindedness for intelligence and mental disorder for personality characterize inferior adjustment. Alertness (or genius) and stability (or sanity) characterize superior adjustment.

From one's intelligence, it is impossible to draw conclusions regarding standing in any particular trait of personality. But superiority in intelligence goes with superiority in personality traits generally. Intelligence may be regarded as one factor or trait of the total personality, and superiority in physical, physiological, and psychological qualities are related to each other. Good physique goes with good chemique and these go with good psychique.

XI. ADJUSTMENT

The action of an organism upon his environment may be adaptive or nonadaptive. With human beings living in society this activity is called adjustment or maladjustment. The criterion of perfection of reaction is adjustment. Under conditions of civilization this criterion is defined in a large measure by the rules and standards of society (folkways and *mores*), which are the social habits of groups of animals and people.

A. The Psychological Activity of Adjustment

A human being, or animal, is said to be intelligent who is able to adjust satisfactorily to his environment. Intelligence is thought of as the capacity for adjustment, and intelligence tests as measures of degrees of adjustment. This is a correct conception, but it is limited to the mechanism of adjustment.

Personality traits influence adjustment in a very large measure. It so happens that persons who are of very superior intelligence, and have learned most that can be learned of any one specialization, are unable to adjust to the conditions of life and are confined in mental disease hospitals. It is truly said that a person must have intelligence to lose his mind. Intelligence (capacity) delimits the learning of adjustive reactions but other personality traits influence these adjustive reactions sufficiently for them to be considered as causative of maladjustment.

B. Maladjustment

Maladjustment is indicated first by unusual reactions in a normal environment. Persons giving evidence of maladjustment are designated as abnormal: (1) if they score in the lower ranges of distributions on intelligence tests (the feebleminded or aments), (2) if they score in the lower ranges of personality measures (the psychotic, neurotic, psychoneurotic, or insane), and (3) if their behavior differs too much from the usual or normal behavior of the other members of the social organization. General observation of clinical symptoms indicates abnormalities of intelligence or personality. While the term abnormality is used to designate the inferior extreme of any psychological measure it refers as well to the superior extreme where adjustment is relatively perfect.

C. Summary

Degrees of adjustment are indicated for personality measures in this chapter and for intelligence measures in an earlier chapter (Chapter VI). The activity of making adjustments to environmental stimulation has been studied as learning and emotion. The total stimulating situation, formed of environmental changes and all influences within the organism, is the cause of adjustment and maladjustment. This is what is generally called heredity and environment.

Part C

INTEGRATION OF PSYCHOLOGICAL ACTIVITY

Integration in the Nervous System and in Awareness

If we wish to understand mental life . . . . we must study the nervous system and how it works, since all our thinking depends upon nerve connections.

—Howard C. Warren
Stuart Professor, Princeton

All of the sciences are concerned with the one world of human experience . . . . Introspection and inspection . . . . denote (its) observation . . . from the different standpoint of psychology and physics.

—Edward Bradford Titchener
Professor of Psychology, Cornell

The effect of integration is observed in reaction. Learned reactions are evidences of adjustive integration. Native reactions show inherited integrations. Emotional reactions indicate integrations in which adjustments to environmental conditions are not perfect. Causative of reaction is the integrative activity within the organism.

Environmental stimuli present situations demanding a change in the integration of reaction in order that there may be an adjustment of the organism. While the effects of this change are observed in reaction, the process itself is in the nervous system and in awareness where integrative stimulation and structure can be studied.

Part C is concerned with the specific problems of integration. In the study of integration, experimental conditions are set so the specific integrative activity in which the experimenter is interested comes under observation. Two of the following chapters deal with integration in the nervous system and three with integration in awareness.

Integration in the Nervous System

Integration in Awareness

A knowledge of structure is necessary to an understanding of integration in the nervous system. Chapters X and XI describe the essential neural structures. Integration develops between receptor and effector; the nerve impulse drains throughout the nervous system into common paths of reaction; innervation of effectors is through intricate nerve connections; reaction is the resultant of complex integrative nerve patterns. Causes of reaction are found in the action of the nerve impulse and in the complex connections of the nervous system.

Nerve physiology is a science so broad that discussion of the activity of the nervous system here can be only schematic and suggestive of how reaction takes form in the nerve action.

In Awareness, integrative activity comes clearly under observation. Here, as in the study of the nervous system, a knowledge of structure is necessary. The structures of the environmental stimulus are described and measured in terms of wave-lengths, pounds, meters, and so on. Similarly, structures of awareness are represented in terms of qualities and discriminations between these existences.

Sensitivities, which were described in an early chapter (Chapter II), are awareness structures correlated with environmental stimulation. But the structures of awareness are usually more complex than thus far considered, as can be realized when a tone is compared with a symphony or a color with a landscape. Awareness may be of a symphony heard or a landscape seen years in the past, which are recalled sensitivities. Thinking and feeling involve such structures of awareness, but in a sequence determined by the stimulation in awareness.

Chapter XII is concerned particularly with the structures of awareness while Chapter XIV discusses the stimulation of psychological activity in thinking. Feeling (Chapter XIII) is discussed as a distinct kind of awareness where motivation is directed toward the goal of individual satisfaction rather than that of efficient adjustment.

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Chapter X

FORMS OF NERVOUS INTEGRATION

The influence of integration on psychological activity is observed in the anatomical relations of nerve structures and in the metabolism of nerve cells. Nervous integration is accomplished through the action of *nerve cells* (neurons) which are in functional relation.

I. THE ORGANIZATION OF NEURAL ANATOMY

A general consideration of the nervous system gives one the impression that there are large and small nerves which are branches of a main nerve trunk called the *central axis* (the spinal cord and brain). In reality however, these units, called nerves, are bundles of nerve fibers.

A. The Nerve Fiber

Each little nerve fiber is insulated by a covering from contact with the other nerve fibers forming a nerve. The essential covering is called the *medullary* or *myelin sheath*. Thus the nerve fiber consists of a core of nerve protoplasm surrounded by a covering or sheath. A second covering (the primitive sheath of Schwann, or neurilemma) often is found outside the central axis. Certain fibers, for example those in the olfactory nerve, have only the *sheath of Schwann*. The core of the nerve fiber is formed of nerve protoplasm specialized for the conduction of energy changes in the nervous system. The sheath, however, is formed of non-conducting protoplasm.

B. The Structural Unit

The structural unit of the nervous system is the *neuron* or *nerve cell*. The nervous system is formed of neurons in structural and functional relationships (Donaldson estimates the number of neurons as 12 billion, 12×10^9).

The neuron is microscopic in size and is composed of the following parts and processes:

1. Cell-Body. The cell-body is a microscopic speck of nerve protoplasm from which the processes of the neuron extend. The cell-body is responsible for the nutrition of the whole neuron.

2. Nucleus. The nucleus is located in the cell-body and carries the specific germinal characteristics of the nerve cell.

3. Axon. Each neuron has an axon, which often attains great length, reaching as far as from the brain to the sacral region of the spinal cord. The axons, and their coverings, are the nerve fibers.

4. Dendrites. The dendrites are the processes of the neuron which are sensitive to stimulation by receptors or other neurons.

5. Other Processes. The outreaching fibrils of the axons and the dendrites are called the *end brush*. There are many very small fibrils reaching from the dendrites of the neuron through the cell body and along the axon to its endbrush. These fibrils are part of the cytoplasm and are thought to be the energy carriers in the neuron.

Nervous integration is the coordinated activity of all these structural units.

II. FUNCTIONAL ORGANIZATION

The nervous system is divided often into 'white' and 'gray' matter. This division is based upon function. The 'gray matter' is said to change the direction of conduction in a selective manner. All nerve protoplasm is gray. 'White matter' is really gray nerve fibers covered, or insulated, with white non-conducting protoplasm, called myelin. The myelin sheaths give parts of the nervous system a white appearance, but only the gray nerve protoplasm has the property of conduction. Change in direction of conduction is at points in the nervous system where the nerve cells are not insulated with non-conducting protoplasm. At these points the nervous system has a gray appearnace.

A. The Synapse

When one neuron forms a functional juncture with another neuron a *synapse* is said to exist. Stimulation of one neuron by another is through the synapse from the end-brush of axons to the end-brush of dendrites. Thus the nerve cells (neurons) are linked together into a functional system.

B. Principles of the Synapse

The synapse is a contact point of stimulation which functions according to fairly well established principles.

1. The Law of Forward Conduction. This law says that all nervous stimulation is polarized at synaptic contacts, with the dendrites as receiving processes and the axons as stimulating processes.

2. The 'All or None Principle.' This principle states that a neuron is either completely stimulated (energized) or not at all.

3. The Hypothesis of Resistance. This hypothesis states that resistance to the transmission of stimulation through the nervous system is greater at the synapse than it is in the neuron.

4. The Hypothesis of Changing Resistance. This hypothesis states that resistance at the synapse changes during learning, fatigue, and under various metabolic conditions.

C. The Nerve Impulse

Nerve excitation, or stimulation, is called the impulse. The exact nature of this energy is not known. It appears to be both chemical and physical.

1. Theories of the Nature of the Nerve Impulse. Nerve energy is the specific property of each neuron. It does not flow from receptor to effector. No one theory of the nature of the nerve impulse is entirely satisfactory but the explosion-fuse theory and the membrane theory are scientifically most acceptable.

a. *Wave Motion Theory.* The wave motion theory calls attention to the analogous condition of water waves and the transmission of nervous energy. It is one of the oldest theories of nerve action.

b. *Electrical Energy Theory.* The electrical energy theory regards the transmission of the nerve impulse through the nervous system as analogous to the conduction of electricity throughout a telephone system. This theory was commonly held during the past generation.

c. *Theory of Explosion Fuse.* The analogy here is one where each neuron gives off energy as it stimulates the next in a chain, similar to the burning of the parts of a fuse as it burns from end to end.

d. *The Membrane Theory.* The tissues of the neuron are membranes which act as differential obstacles to the passage of impulse. The impulse consists of a local electric current formed of positive ions (on the outside of the membrane) and negative ions (on the inside of the membrane) uniting and rendering the membrane ahead permeable as the impulse progresses. This passage of impulse requires a certain amount of time, as does restoration to the normal electrical potential in which there is an absolute refractory period, which is the time required for recovery between impulses, and a relative refractory period, which is the time required for recovery for stimuli of energy above the absolute threshold.

2. Variability of the Nerve Impulse. Nerve impulses are said to vary only in intensity and frequency (number). Even the variation in intensity has been challenged by Adrian who produced evidence that the nerve impulse is of fixed intensity for each neuron. Impulses appear to vary because of: (a) a larger number of fibers being used, (b) a rapid succession of stimulation, and (c) a strong solitary stimulus may initiate two or more successive nerve impulses.

D. The Functional Unit of Nervous Integration

Neurons are organized into functional units between receptors and effectors.

1. The Reaction-Arc Hypothesis. The reaction, which is initiated by the environmental stimulus, is said to result from integration performed by *afferent neurons*, leading from receptors, through *adjustor neurons* in the central axis, and along *efferent neurons* to effectors. This is the reaction-arc hypothesis.

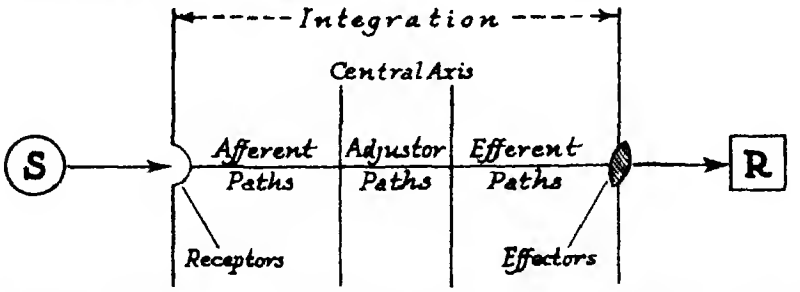

Fig. 14. The Reaction-Arc Hypothesis. Environmental stimuli (S), acting upon specialized receptors, excite afferent neurons of the nervous system which lead to the central axis where an extremely complex adjustment takes place. Upon the drainage of impulses into efferent neurons the effectors are innervated and the reaction (R) is upon the environment (either explicit or implicit).

2. The Structure of the Reaction-Arc. The afferent neurons in contact with receptors, conduct the impulses to the central axis. Contact here is with adjustor neurons which direct the passage of impulses in the central axis. The essential structure of integration is in the central axis where the impulse is conducted throughout the cord and brain. Contact is made with efferent neurons, which carry the impulse to effectors. The organization of afferent, adjustor, and efferent structures make possible the functioning of the reaction-arc.

E. Reaction-Arc Possibilities Within the Nervous System

The organization of neurons into integration patterns is exceedingly complex.

1. Variability of Two-Neuron-Arc. For a hypothetical two-neuron-arc, as the number of synapses increases in arithmetical proportion the number of possibilities of reaction increases in geometrical proportion. Herrick estimates that the stimulation of one million neurons in all possible combinations would give $10^{2,783,000}$ possibilities of reaction.

2. Possibilities of Reaction. There are 12 billion neurons in the nervous system, making possible almost an infinite number of connections. It is thought that all receptors have the possibility of connections with every effector, and that nerve energy may pass along various paths in reaching any effector.

III. THE GENERAL PLAN OF THE NERVOUS SYSTEM

All nervous tissue (nerve cells) can be separated into two divisions according to the functions it performs: (1) the *cerebrospinal system*,

and (2) the *sympathetic nervous system*, (called by some authors the autonomic nervous system). For the present we will be concerned largely with the cerebrospinal system.

The cerebrospinal system may be divided into two smaller systems: (1) a *central system* formed of the central axis, and (2) a *peripheral system* formed of all nerve protoplasm outside the central axis (exclusive of the sympathetic system). Its action is upon the external environment by means of explicit effectors.

A. The Central System

The central system is composed of all nerve protoplasm which is encased in the cranium and vertebral column (the central axis).

1. Brain and Cord. The central system is divided at the *foramen magnum* into the brain and cord. Besides the continuation of the cord superior to the *foramen magnum*, which is called the *brain stem*, there are several enlargements of the brain stem making up the brain, which are called the *medulla oblongata*, *pons Varolii*, *cerebellum*, *thalamus*, and *cerebrum*. These enlargements are masses of the cell bodies of neurons (with their dendrites), which are called *nuclei* or *ganglia*. (The term 'ganglia' often refers to masses of cell bodies outside the central axis which are a part of the sympathetic system).

2. Medial Division of Central System. A great fissure (called the longitudinal fissure at the level of the cerebrum) divides the central axis on the *dorsal* side, and to a degree on the *ventral* side, into two parts. This fissure cuts deep into the nervous tissue almost to the central canal. It forms the two *hemispheres of the cerebrum*. All structures, generally speaking, are duplicated laterally to this medial dividing line. All *ascending fibers* and all *descending fibers* cross (decussate) either at the level of activity or at the level of the brain stem, so that impulses starting at the receptors on the right side of the body and finding their way to higher centers, do so in the left hemisphere of the brain, and *vice versa*.

B. The Peripheral System

This division of the nervous system is composed of (1) the *cranial nerves*, which leave the central axis above the *foramen magnum*, and (2) the *spinal nerves*, which leave the central axis below the *foramen magnum*. The sympathetic system is often regarded as a part of the peripheral system, as it is outside of the central axis, and its action is controlled to a degree by the central axis, but it has distinctive integrative functions of its own.

IV. STRUCTURES OF THE CENTRAL SYSTEM

The back and front of the central system are spoken of respectively as *dorsal* and *ventral* (posterior and anterior) and the sides as *lateral*. Toward the brain is spoken of as *superior*, and toward the cord as *inferior*.

A. The Cord and the Brain Stem

The cord and the brain stem are composed of *projection tracts* (ascending and descending fibers) and nuclei. In general the nuclei, which are formed of cell bodies and dendrites of neurons, are centrally located in the cord and brain stem. The projection tracts, which are formed of the axons and their insulating coverings (nerve fibers), are peripherally located. Below the *foramen magnum*, the peripheral nerves enter the central axis by way of the *intervertebral foramina*, two of which are situated laterally in each spinal vertebra. Nuclei, which consist of the cell bodies of afferent neurons composing these peripheral nerves, are situated inside each lateral half of the spinal vertebra, but just outside the cord proper and in the area of the cerebrospinal fluid. These nuclei are called the *spinal ganglia*. The cell bodies of the efferent neurons in the peripheral nerves are found in the central gray matter of the cord. The nerve fibers leading from the central nuclei of the cord and brain stem go to other levels of the central axis, to striped effectors in the periphery of the body, and to the sympathetic ganglia lying outside the vertebral column of the cord or outside the brain stem in the cranium.

B. Coverings of Central System

Structures covering the central axis (inward from the cranial and vertebral structures) are the (1) dura mater (2) arachnoid (3) cerebrospinal fluid (4) pia mater.

C. The Medulla

The medulla oblongata is an enlargement of the ventral part of the brain stem which is just superior to the *foramen magnum*. Besides the projection fibers of the brain stem at this point, two important nuclei are contained in each lateral half of the medulla, the *nucleus gracilis*, which is immediately lateral to the medial fissure, and the *nucleus cuneatus*, which is lateral to this nucleus.

D. The Pons

The pons Varolii is an enlargement of the ventral part of the brain stem just superior to the medulla. Besides the projection fibers of the brain stem at this point there are masses of *commissural fibers*, circling these projection fibers to connect the two hemispheres of the cerebellum. Also, the pons includes various nuclei, acting particularly as relays for the cranial nerves.

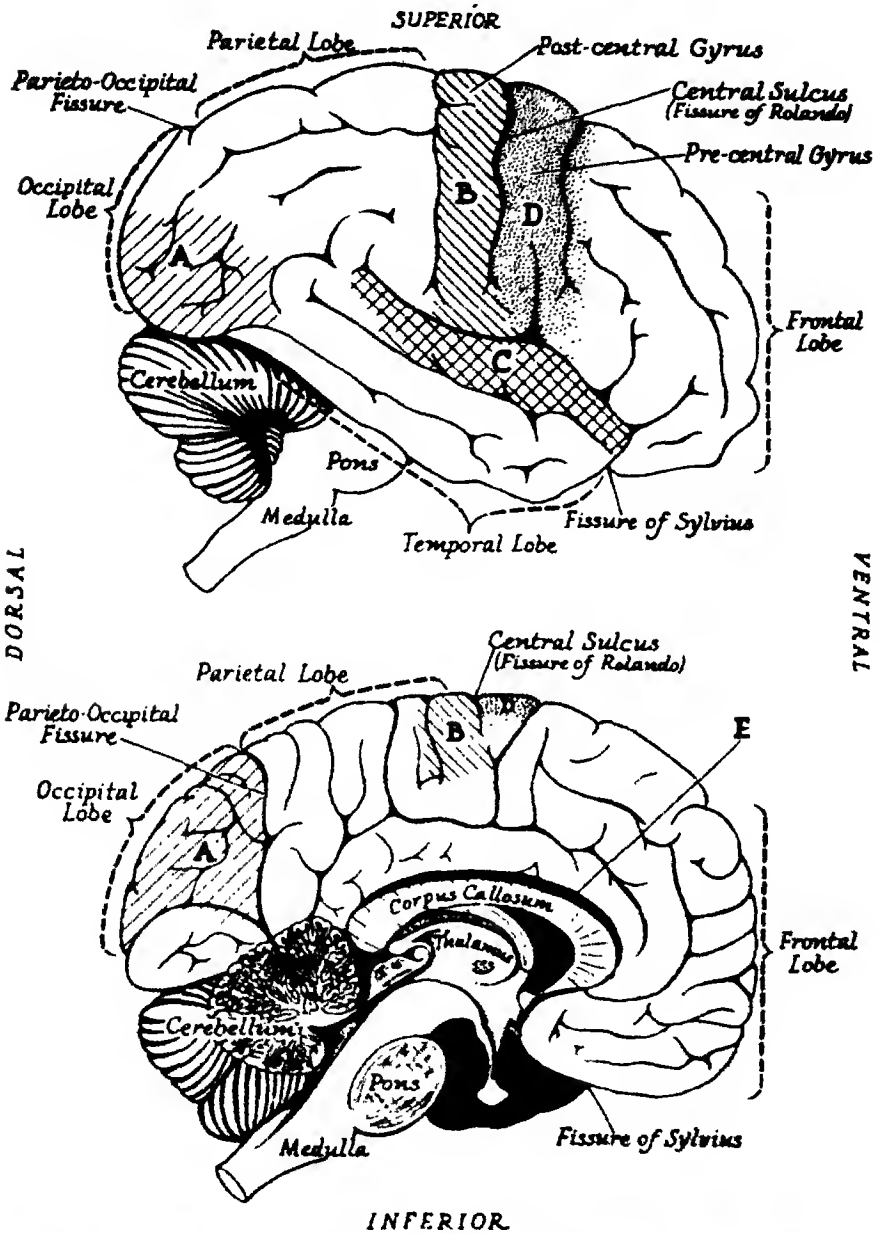

Fig. 15. *Above.* Lateral view of the Right Cerebral Hemisphere. This schematically shows the important fissures, lobes, and projection centers of the cortex, the medulla and pons of the brain-stem, and the cerebellum. The dotted area (D) represents roughly the origin of the main efferent tracts conducting impulses from the cortex to the lower coordination centers and cross-hatched areas (A, B, and C) represent projection areas for vision, somesthesis, and audition, respectively. Unidentified parts are integration areas. *Below.* Mesial view of the Left Cerebral Hemisphere. This figure shows certain structures of the brain-stem, the cerebellum, and the cerebral cortex. The thalamus, corpus callosum (composed of nerve fibers connecting the two hemispheres), and part of the projection area for olfaction and gustation (E) are visible. The essential area of smell and taste, which is not shown in either figure, is the uncus, situated in the hippocampal convolution on the inferior surface of the temporal lobe.

E. The Cerebellum

The cerebellum is an enlargement, the second largest, of the brain stem, and it is dorsal to the pons. The cerebellum is composed of masses of cell bodies (and dendrites) from which axons descend to lower levels of the central axis. The cerebellum consists of two hemispheres, which are formed by the medial fissure of the central axis. Various *fissures* indent the surface of the cerebellum.

F. The Thalamus

The thalamus is referred to often as the *basal ganglion*. It is much older, genetically, than the cerebellum and cerebrum, and in some of the lower forms of life it is the largest structure of the brain. It is located centrally and superior to the pons and is composed of two hemispheres. The thalamus includes a great number of nuclei which act as organization relays to inferior and superior structures.

G. The Cerebrum

The cerebrum is the crowning structure of the central axis, and it includes more neurons in the human brain than all the rest of the nervous system.

1. Hemispheres. The cerebrum is composed of two hemispheres which are formed by the medial fissure. At this point the fissure is called the *great longitudinal fissure*. The *transverse fissure* separates the dorsal part of the cerebrum from the cerebellum.

2. Interlobular Fissures. The lateral surfaces of the cerebrum are divided into five lobes by three interlobular fissures: *Sylvius* (the lateral fissure), *Rolando* (the central fissure), and the *parieto-occipital fissure*. This latter fissure is more prominent on the medial (mesial) surfaces.

3. Lobes. The five lobes of the cerebrum are: *frontal, parietal, occipital, temporal,* and the fifth lobe, at the base of the fissure of Sylvius, called the *Isle of Reil*. There is a small inferior surface of the cerebrum (inferior to the temporal lobe).

4. Convolutions. Each of these lobes has many smaller fissures (sulci), which form smaller lobes, called convolutions (gyri). The medial surfaces of the cerebral hemispheres are broken by fissures and convolutions, all of which increase the surface, or *cortex* of the cerebrum. (Note that the cortex of the cerebrum and the cortex of the cerebellum are composed of gray matter while the outer surface of the rest of the central axis is composed of white matter).

V. STRUCTURES OF THE PERIPHERAL SYSTEM

The peripheral system is composed of afferent and efferent nerves reaching from the periphery of the body to the central axis. These nerves are classified into the *spinal nerves* and the *cranial nerves*.

A. The Spinal Nerves

The spinal nerves leave each lateral half of the central axis by way of the *intervertebral foramina*. There are 31 pairs of nerves and each nerve is composed of both afferent and efferent fibers. There are the following divisions of spinal nerves (in pairs), 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, 1 coccygeal, corresponding to the divisions of the vertebrae which compose the spinal column. The afferent neurons have their cell-bodies in the spinal ganglia and the efferent neurons, which go to striped muscles, in the ventral *horns* of the gray matter of the cord.

B. The Cranial Nerves

There are 12 pairs of cranial nerves leaving the brain stem. Some of these nerves are formed of both afferent and efferent fibers. There are the following cranial nerves in pairs, I olfactory, II optic, III oculomotor, IV trochlear, V trigeminal, VI abducent, VII facial, VIII auditory, IX glossopharyngeal, X vagus, XI spinal accessory, XII hypoglossal.

VI. THE MECHANISM OF NERVOUS INTEGRATION

The mechanism of nervous integration includes receptors, afferent neurons, adjustor neurons, efferent neurons, and effectors. The structure and action of receptors and effectors have been discussed in detail in Chapter I and II.

A. Peripheral System

The action of afferent and efferent neurons is observed in the contacts established in the peripherial system by the spinal and cranial nerves. These neurons conduct the nerve impulse (stimulation) to and from the central axis. Their function is clearly one of conduction and they are insulated for this purpose so that the direction of stimulation is determined in structure.

B. Central System

Integration is primarily the function of adjustor neurons, which are situated in the central axis. There are insulated fibers forming nerves in the central axis, similar to the spinal and cranial nerves, and the neurons of the central axis are organized into nuclei or ganglia, which distribute the impulse (stimulation) over the central axis. The greater part of this integration is performed in the larger structures of the central axis with the cerebrum as the major structure of integration in the higher forms of life.

C. Three-Neuron-Arc

In the action of the spinal nerves, such as those leading from the cutaneous receptors, an elongated dendrite, appearing very much like

an axon and insulated from other nerve fibers forming the nerve, is the receiving process. A hypothetical three-neuron-arc below the *foramen magnum* illustrates the course of nervous integration.

The passage of impulse through a three-neuron-arc is as follows: (1) reception of stimulation or initiation of nerve impulse, (2) passage of impulse by afferent path along dendrite in contact with receptor, through cell body (in spinal ganglion), and along axon to dorsal horn of gray matter of central axis, (4) stimulation by axon end-brush of

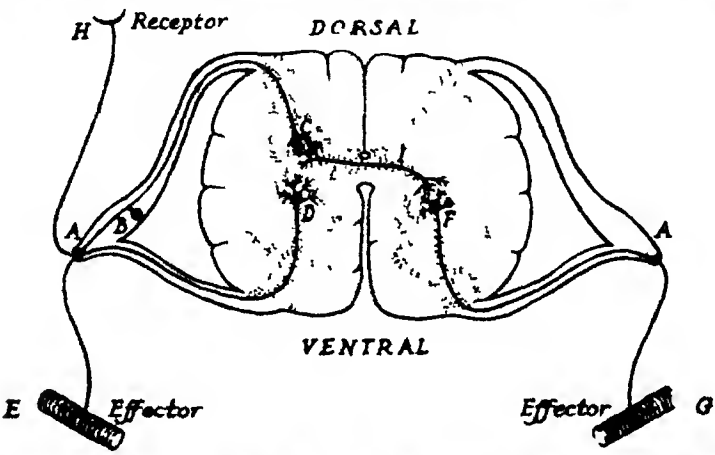

Fig. 16. Integration in the Spinal Cord. A schematic cross-section of the cord showing 'white matter' and 'gray matter' (shaded portion), spinal nerves at the intervertabral foramen (A), and adjustor neurons in the cord. An impulse caused by activity in the receptor (H) traverses the afferent neuron with its cell-body in the spinal ganglion (B), into the dorsal horn of the central axis (C), and the end-brush of the axon forms a synapse with dendrites of other neurons. The impulse may pass to an efferent neuron (D), or to an adjustor neuron (I) which may in turn stimulate an efferent neuron (F) in the opposite half of the central axis. Effectors (E and G) are innervated upon the stimulation of the efferent neurons (D and F respectively).

dendrites of adjustor neuron through synapse, (5) passage of impulse along adjustor neuron through cell body and along axon to ventral horn of gray matter of central axis, (6) stimulation by axon end-brush of dendrites of efferent neuron through synapse, (7) passage of impulse by efferent path through cell body (in ventral horn of gray matter) along axon through intervertebral foramen to effector, and spreading out over motor-end-plate to stimulate a reaction of several muscle fibers.

D. Bell's Law

The statement of polarity of afferent and efferent impulses in the central axis is known as Bell's Law. Afferent impulses traverse fibers entering the dorsal horns of the gray matter of the central axis. Efferent impulses traverse fibers leaving the ventral horns of the gray matter of the central axis.

E. The Drainage Hypothesis

Nerve activity, such as that in the simplest verbal or motor reaction, involves many thousand neurons. The three-neuron-arc illustrates what would take place if integration were reduced to its simplest terms. Nerve stimulation is said to drain throughout the central system into common efferent nerve patterns (common from the standpoint of like response). 'One common path' comes to be used through the repetitions of the reaction. Hence, patterns of reaction are formed. This is called the drainage hypothesis.

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CHAPTER XI

COMPLEX ADJUSTMENTS OF NERVOUS INTEGRATION

Integration in the nervous system is accomplished by means of *centers* of stimulation, which are laid down in the structures of the central axis, such as the cerebrum and medulla. Nerves in the central axis (tracts) form the connections between these centers. Stimulation reaches these centers by way of afferent neurons from receptors, and it travels to effectors by way of efferent neurons after the process of adjustment is completed. All nervous integration takes place through the action of these adjustment centers.

I. ADJUSTMENT CENTERS

Where many cell bodies with their outreaching dendrites are in functional contact so that they may be readily stimulated as a unit, an adjustment center is said to exist. Nerve centers are usually located in the gray matter of the central axis.

A. Anatomy of a Center

A center is a nucleus or ganglion, or a part of these structures, which functions as a unit. A nucleus or ganglion is a collection of cell bodies and their dendrites, groups of which are in functional relation so that they can be stimulated as units. Axons lead from the cell bodies forming these structures to similar structures in the central axis.

B. Kinds of Centers

Adjustments of the central axis are of two kinds, (1) correlation (sensory), and (2) coordination (motor). *Correlation* implies distribution of the stimulation over wider patterns throughout the central axis. *Coordination* implies the determination of patterns of stimulation in relation to effectors.

II. COORDINATION (MOTOR) CENTERS

The term 'coordination' is applied to the activity of a center where the axons of the neurons forming that center have an anatomical arrangement providing for the innervation of a particular group of effectors. There are lower and higher coordination centers.

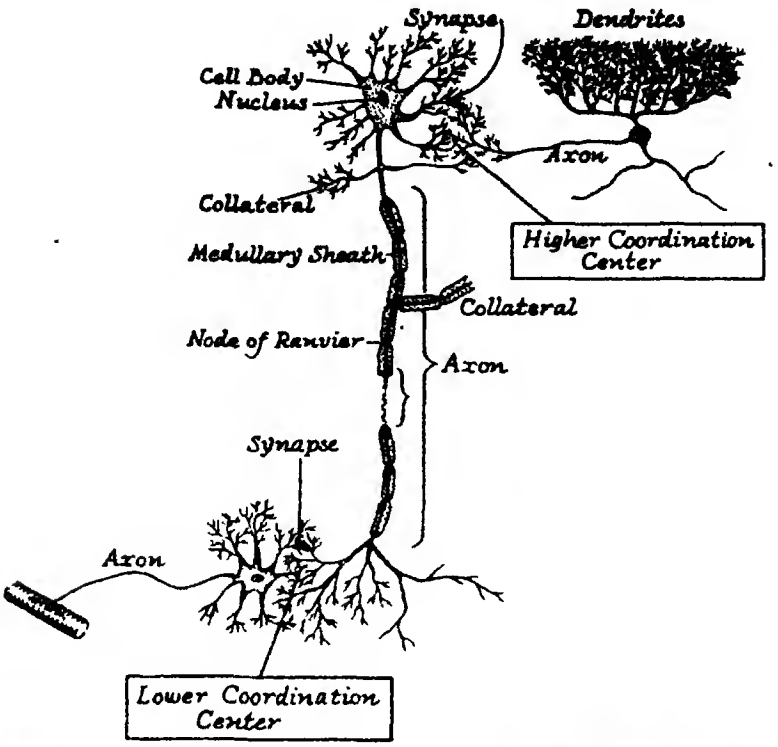

Fig. 17. Organization of Coordination Centers. This schema shows a giant pyramidal neuron in position for stimulation by the axon end-brush of another neuron in what would be a higher coordination center if numerous similar pyramidal cells were in functional relation. Conduction is by way of the insulated axon in the pyramidal tract and the impulse is transmitted from the axon end-brush to the dendrites of a peripheral efferent neuron in a lower coordination center which may be at any level of the spinal cord. The efferent neurons receive the stimulation and conduct to the motor end-plate innervating muscle fibers of the effector.

A. The Lower Coordination Centers

The lower coordination centers are formed of efferent neurons and are usually situated in the ventral gray column of the spinal cord and brain stem. They are in direct contact with the muscle fibers of effectors through motor end-plates. If the lower coordination centers are stimulated the effectors automatically are innervated. The explicit effect is the reaction.

B. The Higher Coordination Centers

Higher coordination centers are located in the cortex of the cerebrum. The 'motor area' lies in the *pre-central gyrus* (ascending frontal convolution) of the frontal lobe. The giant pyramidal cells form the 'motor area' and the axons from these cells become the *pyramidal tracts* (*tractus cortico-spinalis*) which are the main paths of conduction from the higher coordination centers to the lower coordination centers.

Centers throughout the frontal lobe are involved in the more complex coordinations. These centers are stimulated by higher correlation centers. They stimulate other coordination centers until the conduction path to lower coordination centers is involved. 'Broca's area' is a coordination center for speech. This center lies superior to the ascending branch of the fissure of Sylvius. Many of the highly specialized reactions performed by both sides of the body (hands and feet) are coordinated in the left frontal lobe (for right-handed individuals).

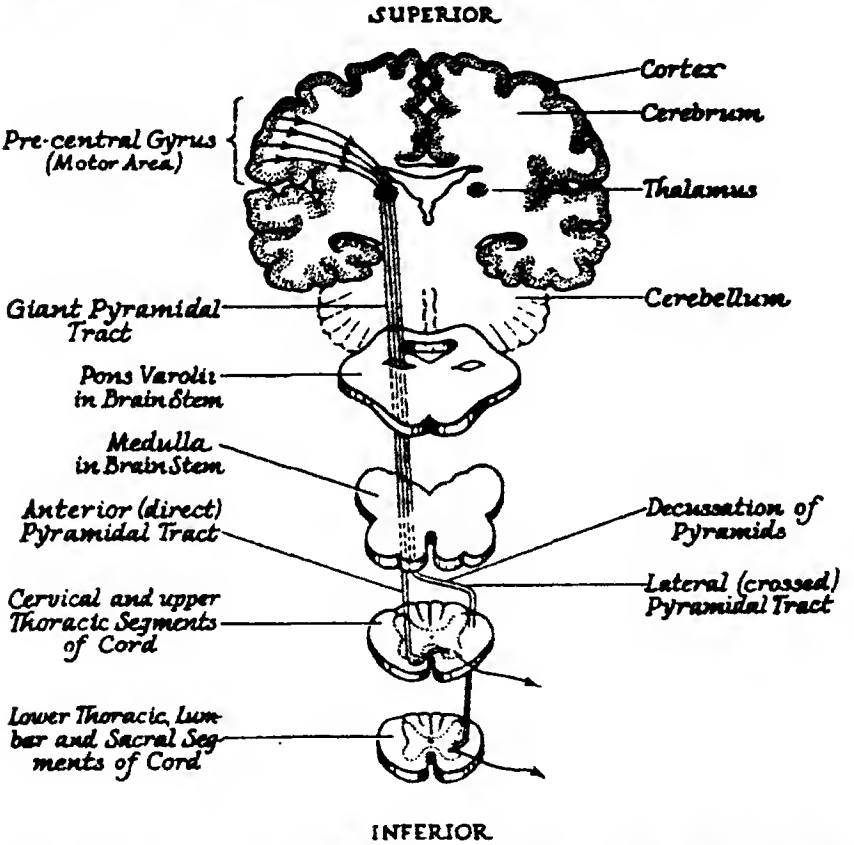

Fig. 18. Descending Tracts. The Pyramidal Tract (Tractus cortico-spinalis) showing direct and crossed branches in the lateral and ventral columns of the cord respectively. The cell bodies (giant pyramidal cells) of neurons forming this tract are found in the pre-central gyrus of the cerebrum and the axons of neurons of the direct pyramidal tract stimulate lower coordination centers in the cervical and upper thoracic segments of the cord while the axons of neurons of the crossed pyramidal tract stimulate lower coordination centers in the lower thoracic, lumbar, sacral, and coccygeal segments of the cord. Crossed and direct pyramidal tracts are duplicated laterally in the central axis.

III. DESCENDING TRACTS

The largest efferent path (nerve) of conduction from higher to lower coordination centers is the pyramidal tract. This tract, which is formed of the axons leading from the giant pyramidal cells of the higher coordination centers in the pre-central gyrus, has two branches for each hemisphere of the cerebrum.

A. The Crossed Pyramidal Tract (Tractus Cortico-spinalis Lateralis)

This tract decussates just below the medulla and is found in the lateral columns of the spinal cord. After the crossing the fibers from this tract enter the ventral gray matter of the same half of the spinal cord at levels of the thoracic region and below, and stimulate the lower coordination centers located there.

B. The Direct Pyramidal Tract (Tractus Cortico-spinalis Ventralis)

This tract descends in the ventral columns of the spinal cord. Fibers leaving this tract decussate in the *ventral commissure* of the cord at the level at which they stimulate lower coordination centers in the ventral gray matter. The direct pyramidal tract terminates in the upper thoracic region. The crossed pyramidal tract consists of fibers reaching to the levels of the cord below this region.

IV. THE SYMPATHETIC SYSTEM (A SYSTEM OF COORDINATION CENTERS)

The sympathetic system has the distinctive function of automatic control of the vegetative activities of the organism. It has three divisions: (1) the *bulbar*, composed of 4 pairs of ganglia located in the cranium, (2) the *sacral*, composed of ganglia scattered throughout the viscera, and (3) the *parasympathetic*, composed of pairs of ganglia situated ventral to the spinal column, one for each of the vertebra, and connected as a chain. The ganglia of the *bulbar-sacral system* are situated far from the central axis, and the ganglia of the parasympathetic are close to the central axis.

A. Central Axis Connections

Pre-ganglionic fibers connect the sympathetic ganglia with the central axis. The cell-bodies and dendrites of the pre-ganglionic neurons are in the lateral-ventral gray columns of the brain stem and cord and the axons reach to the sympathetic ganglia. *Post-ganglionic fibers* make the contact with the smooth muscles and gland effectors. The cell-bodies and dendrites of the post-ganglionic neurons form the sympathetic ganglia.

B. Function of the Sympathetic System

The sympathetic system is efferent (motor) in function. The centers of activity, situated in the ganglia, coordinate the reactions of smooth muscle and gland effectors. Most of the reactions of smooth muscles are rhythmical and this action is coordinated by the centers in the sympathetic ganglia. Direct action upon these centers is by means of preganglionic fibers from the central axis. Afferent impulses from interoceptors in the glands and smooth muscles travel directly to the dorsal horns of the central axis (and the cell-bodies of the afferent neurons are in the spinal ganglia).

V. CORRELATION (SENSORY) CENTERS

Of the three kinds of correlation centers, the lower, intermediary, and the higher, the intermediary are largely projection relay centers.

A. Lower Correlation Centers

The lower correlation centers distribute the afferent stimulation by means of adjustor neurons to different levels of the central axis, either for the direct stimulation of lower coordination centers or for the passage of stimulation to higher correlation centers.

B. Intermediary Correlation Centers

The intermediary correlation centers relay the impulse to higher centers. These centers are in the nuclei of the medulla, pons, thalamus, etc.

C. Higher Correlation Centers

The higher correlation centers are located in the cortex of the cerebrum (see Figure 15). The olfactory and gustatory centers are in the *hyppocampal convolution* on the medial surface of the cerebrum. The auditory centers are located in the *superior temporal convolution*. The visual centers, called the *cuneas* and *precuneas*, are dorsal to the parieto-occipital fissure and largely on the medial surface of the cerebrum. The area of general sensitivity for pressure, pain, warmth, and cold, (for impulses from exteroceptors, interoceptors, and proprioceptors) is located in the *post-central gyrus* (ascending parietal convolution), corresponding to the 'motor area' in the pre-central gyrus. These are the only localizations of sensitivities known.

VI. ASCENDING TRACTS

Ascending tracts conducting stimulation to the centers of general sensitivity (somesthetic area of post-central gyrus) are of three kinds: (1) exteroceptive tracts, (2) proprioceptive tracts, and (3) interoceptive tracts. There is little exact information concerning the interoceptive tracts.

A. Exteroceptive Tracts

The exteroceptive tracts conduct impulses caused by the stimulation of cutaneous receptors to higher centers. The axons of the afferent neurons terminate in the gray matter of the dorsal gray columns of the central axis and stimulate, *via* a synapse, the end-brush of the dendrites of adjustor neurons. The axons of these neurons cross to the opposite half of the central axis through the *central gray commissure* and become a part of the *spinal lemniscus* (*tractus spino-thalmacus*) a few segments above the level of stimulation. Under this name are included tracts in the lateral white column (*tractus spino-thalamicus lateralis*) and in the ventral white column (*tractus spino-thalamicus ventralis*) which lead, without further relay, to nuclei of the thalamus and stimulate,

via synapses, intermediary correlation centers located there. Axons arising in these centers form paths of conduction to the post central gyrus of the cerebral cortex, and stimulate higher correlation centers located there. The crossing to the opposite side of the medial fissure of the central axis, for these tracts, is at the level of environmental stimulation. This system of conduction is the chief ascending path for nervous impulses for pressure, warmth, cold, and pain, which arise in the cutaneous surfaces of the trunk and limbs. There is a different pathway to the thalamus, called the *trigeminal lemniscus,* for cutaneous stimulation of the head.

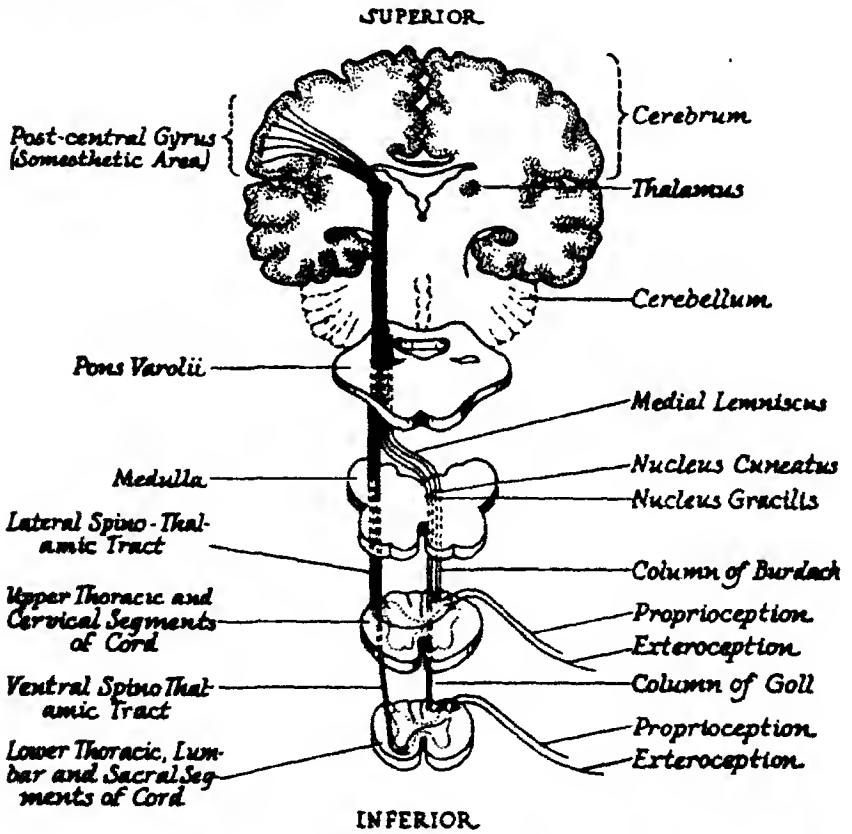

Figure 19. Ascending Tracts. The exteroceptive tracts of the spinal lemniscus in the ventral and lateral columns of the cord are formed of adjustor neurons with their cell bodies in the grey column of the opposite side, and thus their crossing is at the level of excitation. The axons of these tracts stimulate intermediary correlation centers in the thalamus which relay the impulse to the higher correlation centers of the post-central gyrus. The tracts of the spinal lemniscus are duplicated laterally in the central axis.

The proprioceptive tracts (columns of Gall and Burdach) in the dorsal column of the cord are formed of collaterals of afferent neurons with their cell bodies in the spinal ganglia at the level of stimulation. Their axons rise to stimulate correlation centers in the medulla. The crossing is above the medulla in the brain stem and another relay of the impulse is made in the thalamus before there is stimulation of higher correlation centers in the post central gyrus of the cerebrum. The columns of Gall and Burdach are duplicated laterally in the central axis.

B. Proprioceptive Tracts

The proprioceptive tracts conduct afferent impulses, which are caused by the stimulation of receptors in the muscles, tendons, and joints, to higher centers. Branches of axons of the afferent neurons enter the dorsal white columns of the central axis and become fibers of either the *column of Goll* (*fasciculus gracilis*) or *column of Burdach* (*fasciculus cuneatus*). The fibers of Goll are chiefly from sacral, lumbar, and lower thoracic nerves, and those of Burdach are chiefly from upper thoracic and cervical nerves. These tracts terminate, respectively, in the nuclei of *gracilis* and *cuneatus* of the medulla. The end-brush of the axons stimulate the lower centers of these nuclei and axons of a second order conduct the impulses across to the opposite side of the medial fissure of the central axis and upward to the thalamus as a part of a tract known as the *medial lemniscus*. Here intermediary centers are stimulated and the impulse is relayed by axons to the cerebral cortex in the post-central gyrus.

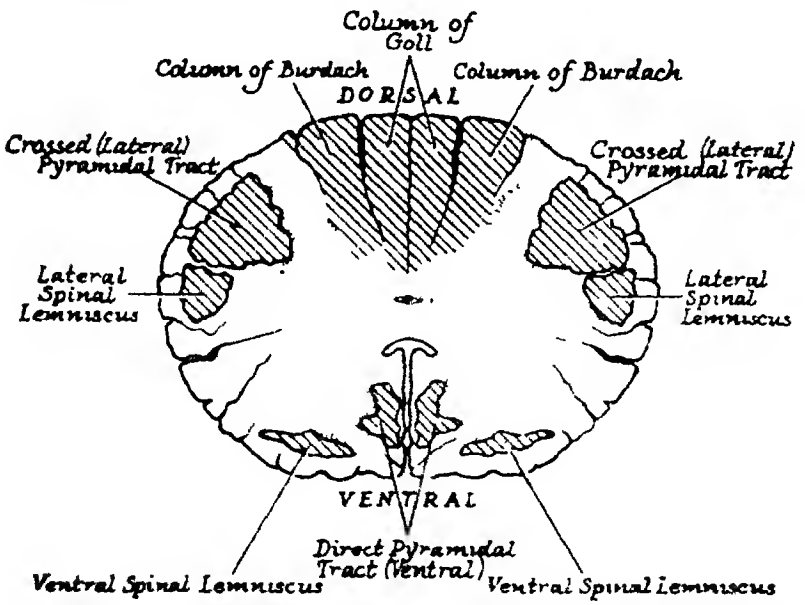

Fig. 20. Schematic Cross-Section of the Spinal Cord at the Fifth Sacral Vertebra. The 'gray matter' (stippled area) and certain important tracts of the 'white matter' (cross-hatched) are shown. The remaining 'white matter' (unidentified areas) consists of other tracts and short projection and transverse fibers.

C. Afferent Tracts from Special Receptors

The special receptors, including the retina of the eye, the cristae ampullares of the semi-circular canals, the rods of corti of the cochlea, the taste bulbs of the tongue, the Schneiderian membranes of the nose, have separate tracts to their intermediary correlation centers in the

medulla, pons, thalamus, and other nuclei of the brain stem. The impulses from these intermediary centers are relayed to the higher correlation centers of the cortex, with one exception: the impulses from the cristae ampullares are relayed from the thalamus to the cerebellum.

VII. LONGITUDINAL TRACTS

Paths of communication from dorsal to ventral centers, and *vice versa,* are called longitudinal tracts. Important longitudinal tracts of the cerebrum are inferior to the cerebral cortex and they connect higher correlation centers, or *association centers,* with higher coordination centers.

VIII. COMMISSURAL TRACTS

Paths of communication across the medial fissure of the central axis are called commissural tracts. The most prominent commissural tracts of conduction from one lateral half of the central axis to the other half are: (1) the *corpus callosum,* at the level of the cerebrum, (2) the *middle commissure,* at the level of the thalamus and connecting both halves of this body, (3) the fibers of the *pons* circling the brain stem, at the level of the cerebellum, and (4) the *ventral white* and *central gray commissures,* at the various levels of the cord and brain stem.

IX. NERVOUS INTEGRATION

Nervous integration is a continuous flow of stimulation from receptors to effectors. The action of receptors initiates this activity which culminates in the action of effectors.

A. The Action of Centers

Nervous integration is effected through the action of centers and paths of conduction between these centers. The cortex of the cerebrum consists of innumerable centers which function between the higher correlation centers and the higher coordination centers. Theoretically, the impulses initiated in each receptor have the possibility of stimulation of every effector through the action of the centers throughout the central axis.

Heredity establishes certain common paths of stimulation through the nervous system to effectors. Also, possibilities for the formation of new paths from every receptor to every effector are contributed by heredity. New connections are made in the learning process, which is one of drainage of impulse into 'new common paths' in the nervous system (drainage hypothesis).

B. The Reaction as a Resultant of Nervous Integration

The psychological reaction involves the following causative factors in nervous integration: (1) the reception of stimulation by means of exteroceptors, proprioceptors, and interoceptors, (2) the correlation and coordination of the nerve impulse by means of afferent, adjustor, and efferent systems—involving centers and tracts, and (3) the innervation of effectors — involving striated muscles, non-striated muscles, and glands. These are the causative factors which are termed nervous integration and which result in the reaction. The psychological reaction is the objective evidence of nervous integration.

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CHAPTER XII

CONSCIOUSNESS

THE STRUCTURE OF AWARENESS

Consciousness, or conscious activity, consists of all psychological activities that involve awareness. These are the most interesting in psychology. When viewed as structures these activities are complex patterns of sensitivities and affectivities, which are referred to as *awareness situations* (awarenesses).

I. THE AWARENESS SITUATION

The environmental situation (environmental stimulus) is studied by the usual objective methods of observation. The awareness situation is analogous to the environmental situation, but it is studied by a special descriptive method of observation, called *introspection*.

The awareness situation has been given various names, according to the complexity of its structure, such as sensation, perception, image, idea, judgment, concept, but the terms, *sensitivity* and *affectivity*, indicate the distinguishing characteristics of all awarenesses. Otherwise, all differences between awareness situations are matters of complexity. An awareness may involve several departments (modalities) of sensitivity, such as vision, pressure, and audition. The affectivity is distinguished as an awareness situation which is considered from the point of view of pleasantness and unpleasantness (feeling). Affectivity is discussed in Chapter XIII.

A. Sensitivities

Sensitivities are classified as *immediate*, which are correlated with the environmental situation, or *recalled*, which are remembered awarenesses.

1. IMMEDIATE SENSITIVITIES (SENSATIONS, SENSE DISCRIMINATIONS). There is hardly an awareness, at least after the first one of childhood, which does not involve past experience. Sensitivities leave a conscious trace, and all future sensitivities are influenced by this trace. Those sensitivities which are correlated with environmental stimulation (when checked with similar introspective reports from other human beings) are called immediate sensitivities. But the usual awareness is a joint product of immediate sensitivity and all past similar experiences.

The sensitivity is immediate in the sense that it is correlated in time with environmental stimulation. Sensitivities have been discussed from this point of view in Chapter II.

2. Recalled Sensitivities (memories, images, ideas). Recalled sensitivities are not correlated with environmental stimulation (when checked with introspective reports of others). There may be environmental changes which are causative of the recalled sensitivity. But recalled sensitivity is largely the conscious trace left by past experience.

Such terms as *perception* and *ideation*, or *imagination*, are used to indicate the degree of relation of the sensitivity to the environmental stimulus. Perception is an awareness in which immediate sensitivity predominates. Ideation is awareness in which recalled sensitivity predominates. Imagination refers to recalled sensitivities with little exact relation in their configuration or organization to the environmental situations. Other terms, such as the *concept* or *judgment*, indicate a final sensitivity in a succession of related sensitivities.

B. Thinking

Immediate sensitivities dominate the thinking of the child. For the adult, who is concerned with mechanical invention or imaginative writing, recalled sensitivities dominate the thought sequence and the activity is highly logical. But the structures of thinking consist of immediate and recalled sensitivities.

Such terms as *abstraction, reasoning, judging, conceptual thinking*, etc., are descriptive terms of a succession of related awarenesses. The individual sensitivities may be immediate or recalled. These terms are used to describe the different characteristics of thinking.

When viewed as causative of a sequence of awarenesses (thinking), the awareness situation is called the *intent* (stimulation in awareness). Integration of psychological activity within awareness is determined by stimulation in awareness. Thinking is successive awareness.

C. The Awareness Situation is Partial

The introspection of the awareness situation is a partial report of psychological activity. Psychological activity is analogous to the waves of the ocean breaking upon the shore. A volume of water flows below the crests of the waves. This corresponds to the automatic mental activities, which are only observable by objective methods. The crests of the waves are all that can be seen, and they correspond to the skips and jumps of awareness. But where awareness is reported, it is in much greater detail than is available in objective observations of the psychological activity. A large portion of important psychological activities can be studied only as awarenesses.

II. DESCRIPTION OF THE STRUCTURES OF AWARENESS

A. Introspection

Reports of awareness under the controlled conditions of an experiment are called introspections. Introspective reports take the form of identification of a *quality*, such as color, pressure, or odor, and the estimation of its *quantity*.

B. Dimensions (attributes) of Awareness

The dimensions of an awareness situation are similar to those of the environmental situation, only the measures of the dimensions are less exact than in physical measurement.

1. Quality. Quality is the name given to any single unitary awareness. It is the hue of a visual sensitivity, the pitch of an auditory sensitivity, the bitter of a gustatory sensitivity, and so on for various sensitivities. It is the hue of a visual landscape, the pitch at a certain moment of the theme of a musical composition, and the momentary bitter of a dose of medicine.

In certain sensitivity departments there are sub-qualities. In vision, the brightness and saturation of the hue are qualitative dimensions. Auditory qualities have an octave and volume difference. These dimensions change the qualitative existence.

2. The Dimension of Intensity. Intensity is the magnitude of the awareness, just as it is of the environmental stimulus and of the nerve impulse. It is referred to by such terms as loudness of the auditory quality and weight and sharpness of the general sensitivities.

3. Protensity (Duration). Protensity is the dimension indicating the time the quality exists. Most introspections are of momentary awarenesses, but the protensity of an awareness may be made the datum of study, as in introspections upon rhythm.

4. Extensity. Extensity is the spatial characteristic of awareness, but not all qualities have the same degree of exactness in this dimension. Explicit pain and pressure, taste, and temperature are clearly localized spatially. Implicit pain and pressure are not so definitely localized. Visual sensitivities are localized at a distance from the body as are auditory and olfactory sensitivities with lesser degrees of accuracy.

C. Boundaries of Awareness (Attention)

The boundaries of awareness are limited by these dimensions of quality, intensity, protensity, and extensity. An awareness of great detail in its dimensions is often spoken of as *attention*. Used in this meaning, attention is synonomous with awareness or the structure described by its dimensions.

Attention, used in this structural sense, is often spoken of as clearness. Certain spatial dimensions of a momentary awareness may be reported more accurately and in greater detail than are others; the same may be true for the dimensions of quality, intensity, or protensity.

Then certain dimensions may be reported as vague and undifferentiated. Reports of this kind have led to a concept of *clearness* as a dimension of awareness. *Figure and ground* (Gestalt category) describes the focus and periphery of awareness as do the *levels of attention* (Titchener). A certain tree stands out in a visual sensitivity as does a musical theme in an auditory sensitivity. But clearness of structure is detail of reported dimensions, while the genetic development of awareness over a period of time may be traced in the focusing (degrees of clearness or attention) of the structures of awareness.

D. Terminology of Awareness

Awareness is consciousness. Both attention and sensitivity are awarenesses. Immediate and recalled sensitivities relate the awareness to different causes. *Configuration* (*gestalt*) is total awareness. All are terms indicating the structural pattern of an awareness as described by the method of introspection. Affectivity is awareness which is reported from the point of view of pleasantness-unpleasantness (P-U).

III. STRUCTURES DESCRIBED IN AWARENESS

The structures of different awarenesses will be listed in the genetic order of their *integration*.

A. Sensitivities

Visual, auditory, taste, and other immediate sensitivities are correlated with environmental stimuli and localized in the environment surrounding our receptors. This is not true of the other structures.

B. After-sensitivities (frequently called after-sensations or after-images)

Various departments of sensitivity show after-effects of stimulation. Sensitivities outlast environmental stimulation. True after-effects of stimulation are adaptation phenomena (see Chapter II).

1. Positive After-Sensitivities. A positive after-sensitivity is a prolongation of the immediate sensitivity after the removal of the stimulus, and occurs either without interruption or after a brief interval. Positive after-sensitivities are present in vision after brief intense stimuli. They are present in pressure, and explained as sensitivities which are due to continuation of the deformation of the skin after the removal of the stimulus. After-sensitivities are observed following intense temperature stimulation, and there is a long positive after-sensitivity (for 10 seconds or more according to Titchener) in dermal pain. Taste sensitivity persists after the stimulus is removed, but this after-awareness is explained as due to the stimulus continuing in solution on the tongue.

2. Negative After-Sensitivity. In vision, the positive after-sensitivity is followed by a negative after-sensitivity, which is of a complimentary or antagonistic quality to that of the original sensitivity. In taste, awareness of sweet is often followed by a bitter taste, but this may be an immediate sensitivity to a complex stimulus. Continuous

warmth is followed by a sensitivity of coolness, but this is under conditions of adaptation to warmth. Paradoxical cold results from warmth stimulation at 45° C., but this is an immediate sensitivity during stimulation and not following the withdrawal of the stimulus. There is no conclusive evidence for negative after-sensitivities except in vision.

C. Synesthetic Sensitivities

Synesthetic sensitivities (called images by some authors) are awarenesses in another sensitivity department than that being stimulated. There is sensitivity, of course, in the department of stimulation, but there is an accompanying awareness in another sensitivity department. Synesthetic sensitivities are scattered throughout all departments, but they are particularly noticeable in audition where an auditory stimulus may cause a visual sensitivity along with the natural auditory sensitivity (termed 'colored hearing'). This peculiar auditory phenomenon has been used as the psychological basis of invention of a color organ which displays in color what are said to be musical rhythms.

D. Recalled Sensitivities (frequently called recalled images or memory images)

Recalled sensitivities represent a later stage in the development of sensitivity to stimulation. They form a large part of the structure of thinking.

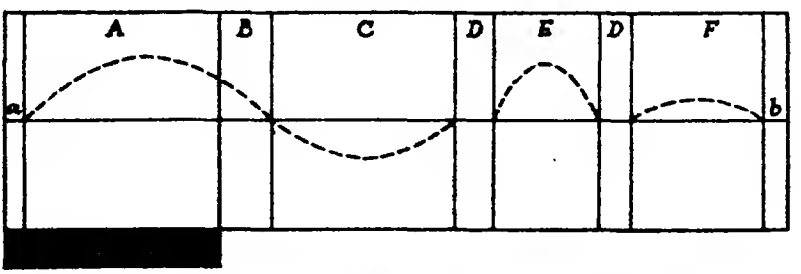

Fig. 21. *The Genetic Development of Visual Awareness.* In this diagram 'time' is indicated on the abscissa. Environmental changes (the S of environment) are shown to be correlated with the immediate sensitivities (the S of awareness). The central horizontal line (a to b) indicates psychological equilibrium or no psychological activity. A (sensitivity) and B (the positive after-sensitivity) are both considered to be breaking-down psychological processes; C (the negative after-sensitivity) is regarded as a building-up process; E (the 'eidetic image'), which is comparable in clearness to the sensitivity, and F (the recalled sensitivity) are breaking-down processes of recall; D indicates indefinite time in the genetic development of awareness. While the diagram represents the development of visual awareness, and to a degree any awareness, it must be borne in mind that many unitary activities are focalizing at various times and no one holds the focus for a long period of time such as is shown in the diagram.

E. 'Eidetic Images'

'Eidetic images' are recalled sensitivities of exceptional clearness. They are most frequently present in young people (usually young children) but are reported by some adults. Various authorities believe that there is an 'eidetic type of mind' (Jaensch, 1930). It is a psychological phenomenon of awareness in which there are wide individual differences.

IV. THE DIMENSIONS OF SENSITIVITY

All awareness situations are sensitivities or successions of sensitivities (thinking), and the usual awareness situation is highly complex, involving several departments of sensitivity as well as various dimensions of these sensitivities. Infrequently is one solely aware of a simple sensitivity, such as a pure tone or a simple taste, and when such a sensitivity does exist it is due to the focusing of awareness upon a quality or quantitative dimension of this quality. In experiments, the focus is determined by the instructions, and in usual psychological activity, it is caused by the natural intent of the person to observe.

A review of the experimental results of introspective studies of the various dimensions of sensitivity will follow.

A. Intensity: Weber's Law

The intensity of a sensitivity is found to be correlated with the magnitude of the environmental stimulus, although various other conditions of stimulation influence this dimension. Weber's Law (Weber-Fechner Function) was stated as a fraction (Weber's fraction) by Weber in 1834 and formulated as a law of sensitivity-stimulus relationships by Fechner in 1860. The magnitude of the physical change is compared with the JND of the sensitivity from the absolute threshold. Intensity of various sensitivities, such as visual brightness, noise, odor, taste, pressure, temperature, and for P-U, increases in arithmetical progression as the magnitude of the stimulus increases in geometrical progression. The law is stated as an equation as follows:

$$S = K \text{ Log } R$$

where "R" is the magnitude of the stimulus, "K" is a constant for the individual subject, sensitivity, and environmental situation, and "S" the sensitivity.

Weber's law is a general statement of the relation of conscious intensities and stimulus magnitudes which holds with exactness only in the middle ranges of intensities. The *decibel* is a measure of magnitude of auditory stimulation which is based on this law.

B. Extensity (Space Sensitivity)

All sensitivities have extensity dimensions in awareness, but spatial awareness of the organism's explicit environment is primarily visual, auditory, and tactual (cutaneous). Various measures of the dimension are called extensity *cues*. Special visual, auditory, and tactual cues in space sensitivity will be discussed in separate sections.

1. Space Sensitivity in Smell and Taste. Exploratory movements of the head enable a partial localization of odors through differences in intensity in the two nostrils. Localizations of tastes on the surfaces of the tongue are exact, but these localizations are unimportant in general space sensitivity.

2. Kinesthetic and Organic Space Sensitivity. Organic sensitivities are localized within the body with varying degrees of definiteness, such as the pressures due to 'gas' in the intestines and dryness of the throat. 'Referred pains' are localized equally well, but are of nervous origin with their causes less definitely or not localized. Postural sensitivity (kinesthesis) is involved in all movement in space although it is not usually focal in awareness. Movements of the eyes and head, of the arms and fingers, and of the entire body are coordinated with other spatial sensitivities orienting the organism in space.

3. Distance and Direction Sensitivity. Distance and direction sensitivity (tridimensional space) is primarily tactual and visual, but other departments of sensitivity are contributors. A change in intensity of an odor or a sound, and even a change in temperature in certain situations is a distance and direction cue. The less intense a sound or an odor the more distant the sensitivity is localized. Any changes in the intensity of a visual, tactual, auditory, or olfactory sensitivity, which are related to movements of the body, is a cue for direction or depth.

4. Localization of Sensitivity (Lotze's Theory of Local Sign, 1852). Locality sign (local sign) is a cue in visual and tactual space sensitivities. In Lotze's Theory of Local Sign and early nativistic theories, local sign was considered to be an inherited property of sensitivity. Today it is an acceptable theory that locality sign develops with the integration of spatial sensitivities.

C. Protensity (Temporal Sensitivity)

Mental time varies with various factors in the total situation.

1. Short Intervals. Temporal intervals in which the sensitivity is unitary are called *short intervals*, and they may range from a fraction of a second to perhaps five seconds. Greatest accuracy of estimate of physical time is approximately at 0.75 seconds with longer intervals under-estimated and shorter intervals over-estimated. Equal short tactual and visual intervals are longer in duration of stimulus than auditory

intervals, because of after-sensitivities. Filled intervals are longer than unfilled ones and those with definite boundaries are shorter than those with indefinite boundaries where the stimulus times are equal.

2. Long Intervals. Longer intervals are filled with unitary short intervals and in their estimation they are broken up into these temporal units. The ability to 'guess time' and wake at a certain hour are products of learning of temporal cues in the total situation.

3. Protensity Succession. Protensity sensitivity consists of successive units or continuous units which may be filled or unfilled. Successive units have an upper and lower threshold where the sensitivity becomes continuous when the stimulation is of the same or approximately the same receptor. The upper thresholds of rate of succession in milliseconds (ms., sigma, thousandths of second), where protensity sensitivities become continuous, are as follows:

For tactual stimuli for different areas,	0.6	to	150.0 ms.
For auditory stimuli of various kinds,	2.0	to	6.7 ms.
For visual stimuli for different areas,	22.0	to	61.0 ms.

Stimulation of the finger tips by a tuning fork gives the highest rate of succession before fusing and becoming continuous. Electric sparks as stimuli in audition have the next highest rate. This threshold varies for different areas and kinds of stimulation and is increased when successive stimuli are alternated among different departments of sensitivity.

The lower threshold of rate of succession, below which sensitivities fuse and become continuous, is at about 750 ms. or ¾ths of a second.

4. Rhythm. In rhythm sensitivity unitary intervals are recurrent and one member of the group is accentuated. Accentuation in the stimulus is a condition to rhythm sensitivity but it is not necessary to it. Tactual, visual, and kinesthetic sensitivities may be rhythmic as well as auditory sensitivities where rhythm is most prominant.

D. Movement

Movement results from successive stimulation in which intensity, protensity, and extensity cues are integrated in the sensitivity. It is present in moving and in stationary situations.

1. Moving Situations (Movement). Sensitivity of moving situations is in relation to the body and its activity. All dimensions of a sensitivity and usually several sensitivity departments are involved in any one movement. Successive changes in brightness, size, shape, direction, and distinctness of a visual sensitivity; of intensity and complexity of an auditory sensitivity; in direction, size, shape, weight, etc. of a tactual sensitivity; and in the rate of all of these changes, form the cues for a sensitivity of movement where the object itself is moving. Cues from smell and kinethesis and other departments of sensitivity not mentioned here may enter the complex integration.

a. *Spatial Separation of Successive Stimuli.* The spatial threshold of succession in both tactual and visual sensitivities is smaller than the two-point limen, with the exception of the fovea in vision where it is approximately the same as the two-point limen. At the periphery of the retina the two-point limen is four times as great as the threshold of succession.

b. *Spatial Rates of Movement.* In vision at a distance of two meters the lower temporal threshold of movement is 0.2 cm. per sec., and the upper temporal threshold about 150 cm. per sec. For other distances than 2 m. from the eye the upper and lower temporal thresholds of rates of movement increase or decrease as the square of the distance. Beyond these thresholds moving objects are seen as standing still.

2. Stationary Situations. Movement within a stationary situation is called *stationary movement* and is present in visual sensitivity (Wertheimer, 1912), in tactual sensitivity (Benussi, 1913), and in auditory sensitivity (Burtt, 1917).

a. *The Phi Phenomenon.* Wertheimer showed that if two slits are made in a screen and each slit is alternately illuminated fairly rapidly the visual sensitivity will be of a light moving from the first to the second position and back again. Wertheimer called this movement the *phi phenomenon* and it has been called *apparent movement.* It is movement in a stationary situation.

b. *Optimum Rates of Succession in Stationary Movement.* The optimum rate of successive stimuli in movement varies for the three departments of sensitivity in which it occurs. The best rate of visual succession in motion pictures is 42 ms. per presentation or above 24 pictures per second. Experiments with simple stimuli indicate that approximately 60 ms. is the optimum rate for visual movement. Experiments with simple stimuli indicate that between 25 and 30 ms. is the optimum rate for auditory movement. For tactual movement the optimum rate of succession is about 75 ms.

c. *Korte's Laws Relating Sensitivity Dimensions in Stationary Movement.* Korte (1915) established laws for optimum visual movement, relating extensity, protensity, and intensity dimensions as follows: (1) Spatial separation (extensity) of successive stimuli varies directly with their intensity. For sensitivity of movement, as the distance between successive stimuli is increased, intensity is increased, and as intensity is decreased, distance between stimuli is decreased. (2) Intensity and rate (protensity) of successive stimuli vary inversely. As rate is increased, intensity is decreased and as intensity is increased, rate is decreased, to establish the best conditions of stationary movement. (3) Rate and spatial separation vary directly. As spatial separation between successive stimuli is increased, rate is increased and *vice versa*, for movement sensitivity.

These laws established for visual stationary movement by Korte have been verified by Burtt (1917) for tactual and for auditory stationary movement.

d. *Intent of Observer* (Attitude). Intent or attitude determines movement sensitivity as to direction and whether or not succession is observed as movement. Recalled sensitivities contribute to movement. Past experience builds the mental set for movement sensitivity.

e. *After-sensitivities of Movement.* Movement is often followed by an after-sensitivity of movement in the opposite direction, in which the velocity of movement is similar.

E. Sensitivity as a Measure of Environment

The environmental stimulating situation is said to be *equivocal.* It is not the exclusive cause of sensitivity in meaning or in dimensions.

1. In Meaning. Meaning is determined by recalled sensitivities or past experience. When not recalled in detail, the meaning of this past sensitivity influences the individual's present observation through mental set. Where recalled in detail it influences present observation in the development of intent. In either case the determination is the genetic result of past meanings and what one observes to have meaning is determined by past meanings in a very large degree.

a. *In Vision.* An experiment by Stratton (1897) illustrates the effect of past experience in vision. Our retinal images are inverted as a physical effect of the accessory apparatus of the visual receptor. Correct adjustment through other sensitivities, such as pressure, has been effected early in life. Stratton reversed the usual retinal image with lenses and his visual environment appeared upside down. But objects soon righted themselves with experience and complete orientation gradually took place. Upon removal of the lenses objects again appeared inverted and, again, reorientation was necessary.

b. *In Audition.* A similar experiment in audition was performed by Young (1928). He directed sounds to the opposite ears through tubes and ear trumpets. Localization of sounds was on the side opposite to the stimulus, but a rapid reorientation took place.

2. In Dimensions. The organism measures its environment with its physiological equipment, such as the eye, semi-circular canals, and taste-buds. Sensitivity is the organism's measure of the environment. Many illusions illustrate the differences between sensitivity measures and physical measures, while some illusions are due to meaning. There are correlations between the physical measures of the environment and the sensitivity measures, as is illustrated in Weber's law of intensity. Other sensitivity measures vary, with little relation to physical measures, as in mental time.

a. *Size and Brightness Constancy.* In vision, size and brightness constancy illustrate the lack of known correlation between physical measures and sensitivity measures.

(1). Size. The physical *law of the visual angle,* which states that the area of an object decreases with the square of the distance, holds for the size of the retinal image but not for the size of the sensitivity. A quarter held at a distance of two feet is not four times as large as it is at four feet. It is about the same size. Visual size sensitivity tends to remain constant for various near distances when other conditions are equal.

(2). Brightness. The physical *law of light intensity,* which states that the brightness of an object decreases with the square of the distance, again, holds for the brightness of the retinal image but not for brightness sensitivity. Brightness sensitivity is of surface and illumination. Brightnesses of surfaces remain relatively unchanged under changes in illumination. A highly illuminated black will never have the same brightness as a weakly illuminated white even though the reflected light intensity of the two objects are equal.

b. *General Constancy of Sensitivity.* Visual shape and color as well as size and brightness tend to be constant under varying physical conditions. Constancy is the rule in all departments of sensitivity; under varying stimulating conditions kinesthetic weight is relatively constant, temperature is relatively constant, and so on.

3. The Development of Sensitivity. It is well to distinguish between a physically measured world and a sensitivity measured world. The sensitivity measured world is the integrated sensitivities of various departments. But as physical measures of the environment are invented the results of these measures are sensed through some department and form part of the integrated sensitivity. Differences in sensitivity among individuals are based upon different developments of sensitivity. Constancy and inconstancy of sensitivity between individuals, and from time to time in the same individual, is based upon this development. The environmental stimulus is equivocal in the sense that sensitivity is essentially determined by the physiological measuring instruments of the organism and by past experience as evidenced in mental set.

V. TACTUAL CUES OF EXTENSITY SENSITIVITY

Tactual extensity is related to the points of stimulation (locality sign), which are learned. Errors in localization vary according to the density of pain and temperature spots, with an average error of accuracy of localization of about 5 mm. Kinesthetic sensitivities of deep pressure and pain integrate with these cutaneous sensitivities in bodily space localizations, direction of movement, size, and weight.

A. Two-point Threshold

The tactual *two-point threshold* is a measure of acuity of tactual space sensitivity. Two-point thresholds were established by Weber as early as 1840.

1. Measures of Two-point Threshold. Representive thresholds for various areas of the body follow:

Tongue-tip	1.1 mm. (.04 inch)
Palmside of last phalanx of finger	2.2 mm. (.08 inch)
Red part of lips	4.4 mm. (.16 inch)
Tip of nose	6.6 mm. (.24 inch)
Back of second phalanx of finger	11.0 mm. (.44 inch)
Heel	22.0 mm. (.88 inch)
Back of hand	30.8 mm. (1.23 inches)
Forearm	39.6 mm. (1.58 inches)
Sternum	44.0 mm. (1.76 inches)
Back of neck	52.8 mm. (2.11 inches)
Middle of back	66.0 mm. (2.64 inches)

2. Vierordt's Law. This law states that the two-point threshold is indirectly proportional to the distance of the area of the body from the axis about which it is rotating, e.g. the tips of the fingers have a lower two-point threshold than the back of the hand and they are farther away from the rotating axis at the shoulders. Vierordt's Law is not in complete accord with all detailed facts, but it is an acceptable general statement of two-point thresholds.

B. Tactual Illusions

Spatial accuracy, in comparison with physical measures, is greater for tactual sensitivity than for other departments of sensitivity. One important tactual illusion (Aristotle's illusion) is observed when the index and middle fingers are crossed and the stimulus is applied (by an experimenter when S is blindfolded) between the two fingers. The illusion is of two objects.

VI. VISUAL CUES OF EXTENSITY SENSITIVITY

Vision offers numerous special cues (measures of dimensions) contributing to the integration of complex sensitivity.

A. Two-point Threshold

The minimal area on the retina necessary to be stimulated for sensitivity varies with conditions of brightness and under the best conditions has a subtended angle of about 10 sec. (of arc). Sensitivity may arise, however, from the stimulation of two separated areas of less than minimal size. The average two-point threshold at the fovea subtends an angle of 60 sec. (of arc). Twenty degrees outward from the fovea the two-point threshold is four times this measure. The two-point threshold is the measure of visual acuity with 60 sec. as the normal. Ratios of this measure in relation to distance are used as measures of near and far-sightedness (myopia and hyperopia).

B. Cues of Visual Space Depending Upon Anatomical Structure

These cues are often called the primary criteria of visual extensity.

1. ACCOMMODATION. When the normal eye is relaxed it is accommodated for any distance very much greater than nine feet. Distinctness of sensitivity, then, as the lens is accommodated within nine feet, is a cue of distance and, also, kinesthesis, localized in the ciliary muscle controlling accommodation of the lens, is another cue. These are monocular cues of visual space sensitivity.

2. CONVERGENCE. When focusing upon objects up to about 20 m. the two eyes converge and offer three binocular space cues: double stimulation (steroscopy), corresponding points, and muscular balance. Beyond 20 m. the lines of regard for both eyes are so nearly parallel that these cues are inoperative.

a. *Double Stimulation or Steroscopy.* Both retinas are stimulated by the same visual field of objects upon which they converge. While some retinal images of each eye are alike or overlap (cyclopean eye) they also are individual, or do not completely overlap, forming double images (stereoscopy). These double images are depth cues. The two eyes have two partially different views of the same object which fuse in steroscopic vision. The steroscope (invented by Wheatstone in 1838) offers to the subject two separate pictures of a field, such as would be viewed by each eye separately, and shows them in position of convergence of the two eyes. The subject integrates them as in normal steroscopic vision.

b. *Corresponding Points.* The focusing of the two eyes on an object brings the image on the fovea of each eye. If the object is a mere point the sensitivity is single. In a visual field accessible to both retinas (cyclopean eye) the images of objects farther and nearer than the focus will be on non-corresponding points (if we intend to see these images without changing focus *double images* appear). Nearer objects are *crossed* and farther objects are *uncrossed*, which are cues of distance. Corresponding points are said to have locality sign, as in tactual space, and nativist theory holds that this function is inherited. However, such locality signs as exist are probably due to learning. The retinal disparity of images, due to double stimulation and to crossed and uncrossed images in viewing solid objects, is called *binocular parallax.*

c. *Muscular Balance.* The muscular balance or lack of balance in kinesthetic sensitivity of the two eyes is a cue to visual space. Each eye is rotated in its socket by six muscles. Donder's Law (1846) states that each position of the eye, when at rest or in movement, has an established amount of muscular torsion however the eye reaches that position. Thus, there is definite kinesthesis for each position reached by the eye regardless of the position of the head.

C. Cues of Visual Space Depending on Learning

These cues, which are often called the secondary criteria of visual space sensitivity, operate in both monocular and binocular vision.

1. Superposition. Objects in the foreground and background of the visual field are sensed as near or far in relation to each other.

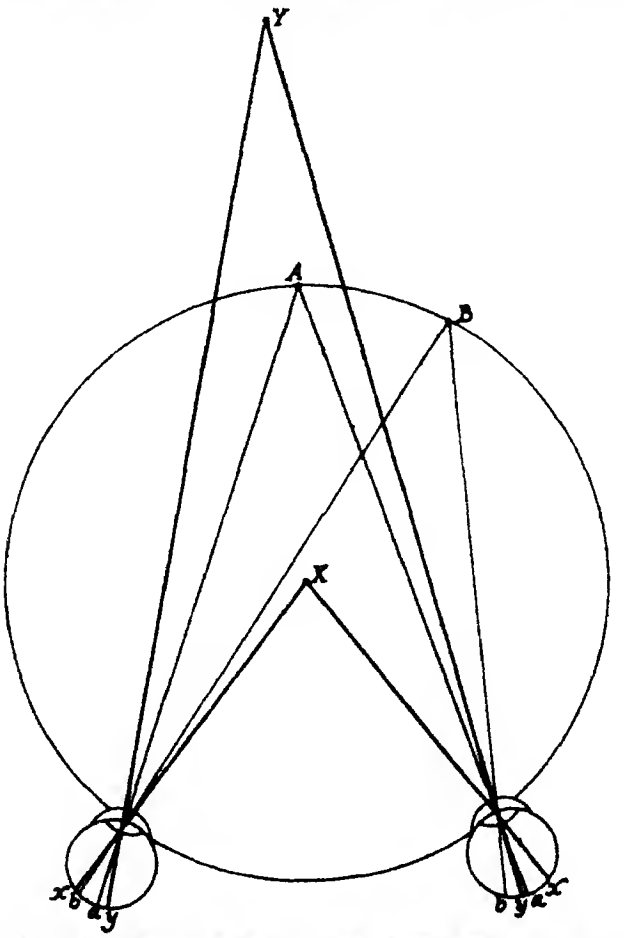

Fig. 22. The Horopteric Circle. When the eyes are focused upon A, images are said to be on corresponding points of the two retinas. Also, images from B, or any other point in the horopteric circle, will be upon corresponding points of the two retinas. Images from X, however, are 'crossed' on the two retinas and images from Y are 'uncrossed' in relation to the line of regard when the focus is at A. 'Crossed' and 'uncrossed' images are 'cues' for distance sensitivity.

2. Perspective. *Aërial perspective,* in which objects are more or less distinctive, and *linear perspective,* in which objects, known to be of the same size, are seen as larger or smaller, are cues in visual distance and space sensitivity.

3. Shadows. The distribution of different brightnesses over a visual field is an extensity cue.

4. Parallax. The apparent relative shift of distant objects in perpendicular movement along the visual line of regard is a cue in visual distance. (Binocular parallax, already referred to under convergence, in which double images appear of unequally distant objects, is also a distance cue.)

These learned cues determine, to a very large degree, the visual space sensitivities of the adult. Also, they are the conditions used by the artist in portraying on the canvas visual space sensitivity.

D. Visual Space Illusions

Visual sensitivities of size, direction of movement, and distance are not in accord at times with physical measurements, as already indicated. A visual space sensitivity which does not conform to established knowledge of the environment is termed an illusion.

1. Size Illusions. The size of the sensitivity is a function of the part of the retina stimulated, particularly as regards the fovea and periphery. Objects stimulating the periphery appear larger than those stimulating the fovea.

2. Ambiguous Perspective Illusions. Where there are relatively few secondary cues of space or distance in a figure the stimulus becomes equivocal in degrees, as in the reversable staircase illusion, and in Titchener's water tank illusion where shadows are seen either as dents or protrusions.

3. Ambiguous Meaning Illusions. Where spacial cues are present in a figure, but where there has been little or no past experience, the stimulus is equivocal, as in Rubin's vase which may be seen as a vase or the faces of two women.

4. Vertical-Horizontal Illusions. Vertical lines appear longer than horizontal lines.

5. Linear Illusion. Linear surfaces are illusionary when angles are included in parallel lines, as in the Müller-Lyer Illusion.

6. Filled and Unfilled Space Illusions. Filled areas appear greater in size than unfilled areas of equal size.

VII. AUDITORY CUES OF EXTENSITY SENSITIVITY

The various dimensions of auditory sensitivity offer numerous cues contributing to spatial awarenesses. There is no such extensity phenomenon as locality sign or two-point threshold in audition as there is

in visual and tactual sensitivities. Intensity, phase, time, and complexity differences of binaural stimulation are the cues of spatial localizations and direction. In monaural intensity and complexity differences there are cues for distance and movement.

A. Monaural Differences

1. Intensity. The less intense the more distant is the localization of the auditory sensitivity. This is due to learning and the integration of auditory intensity differences with sensitivity of other departments, such as vision. Loud sounds are localized as near to the observer and weak sounds as far away. A sound growing weaker is sensed as moving away and *vice versa.*

2. Complexity. The less complex the sensitivity the more distant the localization and *vice versa,* which is interpreted to mean that the fewer overtones the more distant the localization. Again, this kind of localization is due to the integration of auditory sensitivity with other departments and is a product of learning. Also, changes in complexity are auditory movement cues.

B. Binaural Differences

Experimental investigations indicate the individual effect of the various binaural cues to auditory localization.

1. Intensity Differences. Differences in intensity in the two ears result in a spatial localization of the sound in the general direction of the greater intensity. Equal intensity in the two ears causes localization of sound at the center of the head. The absolute threshold of intensity difference between the two ears is about 4 decibels. Greater intensity differences cause the localization to move in related distances to increases in magnitude of stimulus from the center of the head to the extreme side of the head.

2. Phase Differences. Differences in the phase of the sound waves in the two ears result in spatial localization of the sound on one side or the other of the head. When the phases are equal, the localization is at the center of the head. For phase differences of 180° the localization is at the center of the head or the observer is uncertain. Phase leads from 1° to 180° cause localizations in related distances on the side of priority of phase.

3. Time Differences. The absolute threshold of time difference between the two ears for a shift of localization from the center of the head to the side of priority is about 0.03 ms. Increases in time difference cause relative degrees of shift to the side of priority of the stimulus. A time difference of 2 ms. causes two localized sensitivities, one localized at one ear followed by a second localized at the other ear.

4. Complexity Differences. The screening effect of the head upon sound waves shows intensity to be greater for tones of higher frequency than for those of lower frequency. Thus the complexity of a clang or fusion is altered when the source of the sound is nearer one ear than the other and is an effective cue to localization. Localization is most accurate for complex tones and noises.

VIII. RECALLED SENSITIVITIES (REMEMBERING)

Specific recalled sensitivities (frequently spoken of as images) may be classified into approximately the same departments (modalities) as there are departments of immediate sensitivity: (1) visual, (2) auditory, (3) kinesthetic (motor), (4) organic, (5) olfactory, (6) gustatory, (7) temperature, (8) tactual (pressure and pain). Recalled sensitivities do not exist independently of immediate sensitivities. Even the hallucination, which is far removed from any correlation with environmental stimulation, consists of some immediate sensitivities.

A. Individual Differences in Recalled Sensitivities

There are wider differences between individuals in recalled sensitivities than there are in immediate sensitivities. It is seldom that an individual has a full complement of recall departments. Intended recall in certain sensitivity departments is not always possible.

B. Dimensions (attributes) of Recalled Sensitivities

The dimensions of recalled sensitivities are exactly the same as for the immediate sensitivities. The difference between the immediate sensitivities, which are correlated with the environmental stimulus, and the recalled sensitivities, which are not, is purely one of degree of clearness of the dimensions. Extensity and intensity are the ones to be noted particularly in this connection.

C. Forms of Recalled Sensitivities

Recalled sensitivities are found to exist in two forms, just as are the immediate sensitivities: (1) concrete, in which the sensitivity is of the object, and (2) verbal, in which the sensitivity takes the form of the word, or symbol, representing the object. Recalled sensitivities tend to become more and more verbal with increases in age, and the form these recalled sensitivities take is the product of experience.

D. Combinations of Recalled Sensitivities (often called imagery types)

In observation upon the recalled sensitivities, there are found to be a variety of combinations used by different individuals. This is

particularly true of adults. Outstanding combinations are the following:

(1) visual, auditory, and verbal-motor
(2) visual and verbal-motor
(3) verbal-auditory and verbal-motor
(4) verbal-motor

E. 'Reproductive and Productive Imagination'

Two general kinds of recalled awareness situations are usually recognized although they have not been exactly defined in introspective observation.

1. 'Reproductive Imagination'. Reproductive imagination is the recall of past sensitivities more or less exactly as they were experienced.

2. 'Productive Imagination'. Productive imagination is the recall of sensitivities in various new patterns (configurations). Productive imagination is of two kinds: (a) logically controlled, as in invention, and (b) uncontrolled, as in dreams. Exact reproduction seldom exists.

F. Recognition in Recalled Sensitivities

Recognition is acceptance of recalled sensitivities as reproduction of previous awareness. Recognition is characterized by a diffused feeling, called 'the feeling of familiarity' (Titchener).

IX. INTEGRATION IN AWARENESS

Awareness integrates into patterns, configurations, or units (called 'wholes' by some authors) and it does not exist as separate detailed structures, e.g. of blue or sweet (called 'parts' by some authors). No visual, or auditory, or gustatory sensitivity exists alone. Several departments of sensitivity will be affected by any environmental stimulating situation. Recalled sensitivities form a part of any integrated awareness. The intent of the individual determines the configuration of the awareness, or awareness whole. The integration is called context or meaning when reported in introspection.

A. Disintegration in Awareness

The 'stirred-up state' of mind (Woodworth), which is the definition of emotion in awareness, is a condition of disintegration in which awareness is congested with fleeting, or unclear, sensitivities in an unrelated manner.

8. Integration in Awareness

Highly integrated awarenesses, such as reasoning and conceptual thinking, involve a logical sequence of immediate sensitivities and recalled sensitivities (usually formed largely of the latter). This unit of awareness is directed in its integration by intent. The awareness develops with sensitivity following sensitivity over an indefinite period of time until the goal of the intent is achieved.

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CHAPTER XIII

AFFECTIVITY (FEELING)

Affectivity is compared with sensitivity and recalled sensitivity: in affectivity pleasantness or unpleasantness (feeling) is focal; in sensitivity, color, or tone, or bitter, or pain, etc., is focal. The name given the awareness (such as sensitivity or affectivity) indicates the focal activity. In affective awarenesses, pleasantness or unpleasantness is focal and the dimensions of the awareness are vague and undifferentiated. Much of psychological activity appears to be below the surface of the 'stream of consciousness' in the form of affectivity.

I. CONCEPTIONS OF AFFECTIVITY

Various authorities hold to different conceptions of affectivity.

A. Experimental Conception

Pleasantness-unpleasantness (P-U, hedonic tone, affect) is a dimension of affectivity (feeling). It may or may not be present in all awareness situations, and it distinguishes the awareness as an affectivity. P-U is a quantitative variable ranging from extreme pleasantness through indifference to extreme unpleasantness, in terms of which awareness can be reported in introspective observation. This view has had many variations at different periods in experimental psychology.

B. Physiological Conception

Affectivity is an undeveloped sensitivity (Titchener), and the free nerve endings below the cutaneous surfaces are regarded as the receptors for affectivity. This view assumes that all sensitivities (and affectivities) might be classified according to the specialization of function of receptors.

C. Genetic Conception

Affectivity is regarded as generic awareness. It is the primordial awareness, out of which sensitivities have developed and specialized, but it is vague and undifferentiated awareness (Hall). This is the genetic view of the specialization of awareness under adaptation to the environment.

All three of these views are instructive. The only contradiction appears between the second and third as to the evolution of sensitivity.

The conception that the free nerve endings are the receptors for affectivity seems to be unsupported by what is known of the functions of these organs. The experimental view is based upon a development of method, and its theory has changed with changing schools of thought in introspective psychology.

II. THE AWARENESS SITUATION IN AFFECTIVITY

Affectivities are awarenesses in which the observer's intent is to observe P-U or in which P-U is focal in the awareness situation.

A. Correlation with Environmental Stimulus

The environmental stimulus, which is correlated with any affective awareness, may be a word, an act of a person, or any physical change. But very infrequently are environmental changes the essential part of the stimulation causing an affective awareness. Visual sensitivities of a certain person may appear to be the stimulus to fear or subservience. An article which is out of place may appear to be the stimulus to unpleasantness and anger in a housewife. But the stimulation of affectivity is genetically much older and more complex. It is imbedded in near-conscious and unconscious motivation. The motivation of feeling is a mental set, and any environmental stimulus, which is correlated with affectivity, is likely to be only the 'final cause' of the affective awareness.

B. Affectivities of Abnormal People

In abnormal people, affective awarenesses are caused by previous affective awarenesses, which themselves are caused by earlier affective awarenesses, and so on, as in manic-depressive psychoses where the affective awareness rolls on and on of its own momentum. Environmental stimulation plays but a very small part in the affective awarenesses of the extremely abnormal individual. The cause is a special form of the mental set called the *emotional set*. In normal people affective awarenesses are caused by mental sets in a similar manner. The essential causes of affective awarenesses are the products or traces left by experience.

C. Complex Awarenesses

Affective awarenesses are usually complex awarenesses. So are thinking awarenesses, where immediate sensitivities play but a small part in the development. Just as it is possible to describe the qualities of certain sensitivities, so is it possible to estimate feeling as a variable of the awareness. A color or a tone is pleasant in degrees, just as it is intense or has magnitude. It is possible to experiment with simple awarenesses in this way. But complex awarenesses tend to be more or less affective, so the general distinction between affectivity and sensitivity is useful. Highly affective awarenesses are much less

differentiated and detailed than are those of thinking. The pleasantness or unpleasantness is focal and an observer reports just that: "I am feeling pleased, or displeased."

III. PLEASANTNESS AND UNPLEASANTNESS (P-U OR HEDONIC TONE)

Any awareness situation may be judged as pleasant, unpleasant, or indifferent.

A. The P-U Variable

This judgment is 'absolute' for each awareness. But each judgment of a certain affective awareness may be related to other affective awarenesses for comparison. The judgment becomes one of degrees when affective awarenesses are compared and ranked. Thus, feeling becomes a variable of awareness which extends through degrees of

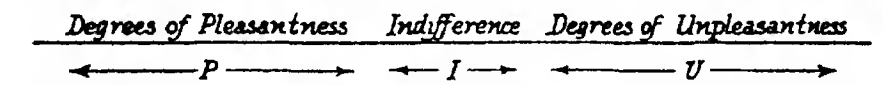

Fig. 23. *The P-U Variable of Awareness.* Pleasantness, Indifference, and Unpleasantness are dimensions characterizing all experience. Indifference is never exactly determined. Where the awareness is indifferent it should properly be called a sensitivity.

pleasantness to indifference and through degrees of unpleasantness. The zero of indifference is never exactly determined; many awarenesses may be indifferent when compared with pleasant ones while compared with unpleasant ones they are pleasant. The same situation exists with unpleasant awarenesses.

B. The P-U Variable as a Dimension of the Awareness Situation

There is disagreement among authorities as to the status of P-U (hedonic tone) as a true dimension of the awareness situation comparable to intensity and protensity. Practically and experimentally it is a dimension in terms of which all awareness situations may be observed. Introspection of P-U is determined by intent to observe P-U, just as introspections of intensity and protensity are determined by intent to observe these dimensions. In this sense P-U is a dimension of the total awareness situation.

However, at the present time and until more information is available, P-U may be regarded as a feeling evaluation of the awareness situation following observation of the awareness.

C. Psychological Methods of Estimation of P-U of Simple Affective Awarenesses (Methods of Impression)

Fechner (1871) developed three *scaling methods* for judgment of the hedonic tone of simple awarenesses such as odors, colors, and tones.

1. Order of Merit Method. In this method the observer ranks a series of stimuli by comparing each member with each other member until he has them in the order of feeling preference along the variable from pleasantness to unpleasantness.

2. Method of Paired Comparison. Each member of a series of stimuli is paired with each other member for judgment of preference. Each pair is presented with each member in the first and second position.

3. Method of Single Stimuli. Each member of a series of stimuli is presented individually for judgment upon a scale of values of (a) pleasantness, (b) indifference, (c) unpleasantness, or upon a more detailed scale which includes degrees of pleasantness and unpleasantness.

When these methods are used in the study of affective awarenesses a large number of judgments is always secured and the results are treated statistically to arrive at averages and deviations from averages.

D. Measurement Methods of Estimation of Complex Affective Awarenesses

Methods of estimation of complex affective awarenesses have evolved in the field of mental measurement along with other testing techniques.

1. Interest Measurement. Complex stimulating situations, such as the occupations and the activities of people, are assembled into an *inventory* (questionnaire) for judgments of pleasantness, indifference, and unpleasantness by the method of single stimuli. Scales of common interests of various social groups, e.g., occupational, educational, social, and fraternity groups, have been prepared, based upon the differences in interests of these groups and of people in general, so that an individual's interests can be rated by a quantitative scoring technique according to the interests of various social groups.

2. Attitude Measurement. Similarly, complex stimulating situations which relate to an important social problem of life, such as exclusion of the Japanese on the Pacific Coast, unrestricted voting of the negroes in the South, and so on, are listed in a questionnaire for judgments by the psycho-physical method of single stimuli. The questionnaire is scaled (in scores) for average, superior, and inferior social attitudes, and an individual can be given a score in various social attitudes.

Interest and attitude measurement have contributed a method of generalization upon affective awarenesses in an individual, based upon what are the usual affective awarenesses of other people.

IV. INVESTIGATIONS OF AFFECTIVITY OF AWARENESSES

Any awareness may be described from the point of view of its affectivity.

A. The P-U of Simple Awarenesses

The P-U (pleasantness and unpleasantness) of simple awarenesses was investigated first by Fechner in 1871, who established the problems

for investigation in this field. There are few conclusive statements which can be made about the P-U of simple awarenesses, although the field has been thoroughly worked by numerous investigators.

1. Vision. Washburn (1911) and other investigators find that visual hues at the extremes of the spectrum (R and B) are generally more pleasant that those in the middle (Y and G). The more saturated colors are more pleasant than the less saturated (Cohn, 1894).

2. Audition. There is an inverse relation between P-U and frequency of vibration of single tonal stimuli (Ziehen, 1914). There is a preference for fusions where low numbered fractions exist between the frequency of the two registers (Valentine, 1913).

3. Taste. The P-U order of tastes is represented by sweet, sour, salt, bitter (Engel, 1928).

4. Touch. Softness and smoothness are more pleasant than stiffness, roughness, and coarseness (Major, 1895).

5. Smell. Fragrant, ethereal, spicy, and resinous odors are usually pleasant, while putrid and burnt odors are usually unpleasant (Henning, 1916).

6. Pain. Pain is usually unpleasant but mild pains are often pleasant in complex awarenesses such as the taste of wine.

These relationships are general tendencies which are the product of learning. While P-U is said to be common for various awarenesses, variability between individuals is considerable. These preference relations for simple awarenesses are fairly permanent for a period of about a year.

B. Complex Awarenesses and P-U

Complex awarenesses appear to be pleasant or unpleasant (or indifferent) because of an individual's relations in his social environment. Social groups have common pleasant and unpleasant awarenesses. There is a high correlation between the P-U of awarenesses of the individuals in the same social group, and a low correlation between the P-U of awarenesses of the individuals in different social groups. Up to 14 years there is about a 50-50 chance that the P-U (interest) of an occupational or educational awareness will be the same one year later. But the permanence of the P-U of complex awarenesses increases with age until they are quite stable in later life.

C. P-U and Intensity

P-U varies with the intensity of the qualities of simple awarenesses. Engel (1928) shows increases in pleasantness for all four tastes with slight increases from the absolute threshold in magnitude of stimulus to a certain point. This is followed by a decrease to extreme unpleasantness

for all tastes but sweet as the magnitude of stimulus is further increased. Sweet continues at a maximum of pleasantness with all further increases in magnitude of the stimulus. The most pleasant magnitude of stimulus for the four tastes follows (Engel):

Tastes	*Stimulus*	*Percentage Concentration*
Sweet	Cane Sugar	9.0
Salt	Common Salt	2.0
Sour	Tartaric acid	0.28
Bitter	Sulphate of Quinine	0.0005

D. Contrast Effects

P-U depends upon past P-U in a unitary awareness situation. This is called successive contrast, but it seems to be effective only within one department of sensitivity, such as vision. Successive contrast in P-U is an instance of *relativity* of affectivities. It is what makes certain judgments more pleasant when compared with unpleasant stimuli than when compared with other pleasant stimuli. It makes all of the interests of a certain social group more pleasant for one person than the interests of another social group. The pleasures of the rich man are said to be no greater than those of the poor man which is according to the *principle of relativity in P-U.*

V. THEORIES OF AFFECTIVITY (FEELING AWARENESSES)

Numerous theories have been developed in explanation of P-U activity. One of the older ones, which is frequently referred to, will be mentioned, along with several of the more recent theoretical statements.

A. Wundt's Tri-dimensional Theory of Feeling

Wundt (1896) concluded from experimentation that there were three qualitative variables of feeling: (1) pleasantness-unpleasantness, (2) strain-relaxation, (3) excitement-calm. In his theory, feeling is considered as complex affectivity. The second variable (strain-relaxation) has been described as numerous sensitivities (Royce). The third variable (excitement-calm) was also described as sensitivities (Titchener). This reduces affectivity (feeling) to a P-U variable.

B. Nafe's General Sensitivity Hypothesis

Nafe's introspective investigations of affectivity have led him to the hypothesis that P-Us are patterns of general sensitivities, namely, bright and dull pressures, respectively (1927). Bright pressure is vaguely localized in the upper part of the body and dull pressure in the abdomen. Thus P-Us are implicit pressure sensitivities according to this theory.

C. The Heuristic Hypothesis (Beebe-Center)

P-U (hedonic tone) is due to specific action in sense-organs, which is reported upon instructions to observe P-U, but which would be reported as bright and dull pressure upon instructions to observe sensitivities (1930). The density of P-U is a correlate of intensity of stimulus under P-U instructions, just as the intensity of sensitivities is a correlate of intensity of stimulus under sensitivity instructions. The P-U activity is always implicit and the result of the stimulation of proprioceptors, and the existence of an affective awareness is dependent upon intent to observe P-U.

D. Central Physiological Theory

P-U is a function of nervous activity in the thalamus. This theory is based upon observation of the behavior of animals and humans where destruction of parts of the brain have taken place. It is related to the theory localizing emotion as a function of the thalamus.

All of these theories, which relate various aspects of P-U, are supported by experimental evidence.

VI. AFFECTIVE REACTIONS (OBJECTIVE OBSERVATION OF FEELING)

Reactions have been measured from the point of view of their expression of feeling, or pleasantness and unpleasantness.

A. Amount of Information

Amount of information in a certain field of human activity has been taken as an indication of pleasant hedonic tone (interest) in this field. Associations, made in a free association test, which are expressive of a certain field of human activity are also regarded as indicative of pleasant feeling (interest) in this field. This form of measurement is based upon the assumption that the development of verbal reactions in a field of activity, to a greater degree than other fields of activity, suggests that there is greater interest in the activities in this field.

1. Information Tests. Information tests of interest have been developed in such fields of human reaction as the following: agricultural engineering (Burtt, 1922), general trade activities (Toops, 1923), mechanical activities (O'Rourke, 1926), social activities (Ream, 1921), women's occupations (McHale, 1922).

2. Free Association Tests. A free association test of interest has been developed by Wyman (1925) to discriminate between the following fields of reaction: intellectual, social, and activity.

B. Completion Preferences

Affective reactions have been studied as completion preferences. A series of chords may be sounded on the piano and the observer asked to complete them to his satisfaction. Various geometrical figures

are presented to observers with instructions to complete them so that they may have maximal esthetic value. Lund and Anastasi (1923) found a strong tendency existing to complete visual figures according to familiar objects and according to balance and symmetry. It is possible to study various preferences, such as tastes and smells, in this same manner.

VII. THE GENETIC DEVELOPMENT OF P-U AWARENESSES

A. Inherited P-U Awarenesses

The experimental question is raised whether P-U awarenesses are the product of maturation or if all hedonic awarenesses are the result of training. Whether or not there are inherited P-Us can only be interpreted from the preference reactions of the infant.

1. Theories of Inherited Preferences. Stern (1914) states that there are preferences (P-Us) from the first day of life. Woodworth contends that certain stimuli, such as sweet tastes, bright colors, smooth tones, and simple rhythms, are inherited 'likes' and that there are inherited 'dislikes'. He thinks that the 'feeling of unfamiliarity' (unpleasant) and the 'feeling of familiarity' (pleasant) may be included among the inherited 'likes' and 'dislikes'.

2. Experiments on Color Preferences. Color preferences of infants under six months are based upon brightness (Shinn). Marsden (1903) established the P-U order of saturated colors as red, yellow, blue, and green. After six months of age color preference is based more on hue and the warm colors (red, yellow, and orange) are preferred (Valentine, 1914). There is a gradual decrease with age, following the first years, in the preference for warm colors (reds and yellows) and by adolescence a general preference for cold colors (greens and blues) has developed. Individual variability also increases with age, and is the chief difference in color preferences between adolescents and college students (Dashiell, 1917).

3. Experiments on Tonal Intervals. Prior to the age of six, and prior to musical training, discords are liked as well as chords (Valentine, 1913). With increase in age, a gradual decrease in preference for discords takes place. The order of preference for musical intervals is established about the seventh year and changes very little with increase in age. It is as follows: octave, major third, major fifth, minor second, major seventh (Dashiell, 1917).

4. Inherited and Learned Preferences. It is a safe conclusion that both maturation and training are responsible for P-U preferences. It is evident, for example, that visual preferences exist without opportunity of learning. But such preferences change rapidly and in various ways. There would seem to be inherited P-U of simple awarenesses, and affectivities develop according to accepted standards of society.

B. P-U Balance in Awarenesses

It has been frequently stated that adjustment to life is a struggle to maintain a pleasant balance over an unpleasant balance of affective awarenesses. Flügel (1925) shows that P-U events are in the following proportions in the life of adults: P = 50 percent, I = 28 percent, U = 22 percent.

C. Development of P-U Awarenesses

Stern (1914) states that hedonic tone occurs first with implicit sensitivities, as in hunger, and later with explicit sensitivities (first contact and later distance). Cason (1930) shows that in elementary school children 15 percent of 'annoyances' involve non-human objects, and activities (stimuli) and 57 percent involve human activities. Jersild (1931) shows that P-U awarenesses of college students largely involve social activities.

VIII. HEDONIC TONE (FEELING) AND MOTIVATION

Any specific environmental situation may be correlated with an affective awareness. Environmental stimuli, which are segregated as motivation stimuli and cause a specific motivation effect, are found to be correlated with pleasant and unpleasant awarenesses, but also with indifferent awarenesses. It is a debatable question whether or not P-U awarenesses are any different in their motivation effect from those where the awareness is indifferent. Woodworth (1918) contends that they are. Also, the question is debatable whether pleasant or unpleasant affective awarenesses have similar motivation effects, if any.

Many theories have been developed in which feeling (P-U) is regarded as a motivating factor in learning, in memory, and in accomplishment or achievement.

A. 'The Law of Effect' in Learning (Thorndike)

A pleasant awareness following a reaction is said to 'stamp-in' a learned reaction and an unpleasant awareness 'stamp-out' this learning. A tremendous amount of research has been accumulated in support of this theory and Thorndike has many followers in accepting it. But many psychologists regard the evidence as not supporting this interpretation of P-U as the cause, and believe that such factors in the stimulating situation as 'knowledge of results' and 'rivalry', are the causes of the learning. (This theory is discussed in Chapter VII).

B. Reward and Punishment as P-U Motivating Situations

Reward, or praise, and punishment, or blame, have been widely used for generations as motivation stimuli in the training of animals and children. In learning experiments, a P-U awareness is said to exist when the environmental stimulus is reward or praise (pleasant),

or punishment or blame (unpleasant). But the P-U awareness is never analyzed, as the experimental work is usually performed with animals and children. It is an assumption that P-U is the cause of learning.

C. Interests (Complex Affective Awarenesses) and Achievement

In the field of interest measurement the theory has developed that interests are motivating factors in success, but there is little positive evidence upon this point. Several investigators have attempted to distinguish successful and unsuccessful salesmen by their interests only to find that there are no discriminating interests of successful salesmen (Ream 1924, Craig 1924, Freyd 1926).

D. Motivation Effects of Feeling on Memory

A popular 'common sense' theory has developed that pleasant events are remembered better than unpleasant events. Psychoanalytical theory embodies this conception and states that we tend to forget the unpleasant more than the pleasant. Research supports this contention but not to the extent usually thought to be true. Henderson (1911), reports results as follows for recalled incidents: P = 55 percent, I = 12 percent, U = 33 percent, but he points out that agreeable incidents in our lives probably far outnumber disagreeable ones and Flügel proved Henderson's contention. So the problem becomes one of frequency of recall of P-U events when presented to the subject experimentally.

Pleasant events are likely to be recalled more frequently than unpleasant events, but not in anything like the same proportions as were early indicated. For example, Thompson (1930), after having subjects write down P-U events as they occurred finds that on recall two weeks later, 33 percent of pleasant and 31 percent of unpleasant are recalled, and one month later 24 percent of pleasant and 19 percent of unpleasant are recalled.

E. Motivation and Interest in Recall of Tasks

Zeigarnik (1927) showed that uncompleted tasks were recalled about in proportion of two to one over completed tasks. She further showed that interesting tasks, which were not completed, were recalled in about the same ratio to indifferent tasks. But interesting tasks, which were completed, were recalled in much larger proportions (65%), while 39% of uninteresting tasks were recalled. Thus, motivation (psychological tension) appears to be separated from pleasantness as the essential cause of recall.

IX. HEDONIC TONE AND SOCIAL ACTIVITY

A. Esthetics

The development of art, literature, and music, depends upon their appeal to feeling. In searching for the factors involved in

esthetic satisfaction, conscious meaning of the stimulating situation (its 'expressiveness' or 'totality of effect') is regarded as highly important. The investigation of the P-U of isolated tones, colors, forms, and so on, contributes less to knowledge of esthetics than does the study of complex meaningful wholes. Those experiments (and they have been few) in which the P-U of meaning of the stimulation was subjected to study, indicate that there is even greater individuality in these affective awarenesses than exists for single colors and tonal fusions. What uniformity of feeling there is for meaningful wholes seems to be due to the form, color, rhythm, and so on, of nature, and to such deviations from nature as have social approval.

8. Social Groups

Society is an organization of social groups, which are related or unrelated, based upon various psychological factors. One very important factor causing social organization is commonness of feeling (like P-U). Affective awarenesses (interests) are found to be correlated with social organization.

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THINKING

Chapter XIV

Integration in Awareness

The various sensitivities (which are correlated with environmental stimuli) and the recalled sensitivities of earlier environmental events are under the direction of stimulation in awareness, which is termed the intent. We observe what we intend to observe, and we remember what we intend to remember. Integration in awareness is caused by the intent or near-conscious tendencies. Awareness is activity, just as is behavior. Awareness events follow awareness causes, which in turn become causes for later events. Awareness is integrated in all its dimensions by intent. Intent determines the clearness of structural dimensions as well as the sequential flow of conscious activity (thinking).

I. THE AWARENESS SITUATION

Stimulation in awareness is comparable to stimulation in behavior. What is reaction in behavior becomes the stimulus of other reactions. So sensitivities in awareness become the stimuli of other sensitivities and recalled sensitivities.

A. The Development of Awareness

Awareness is always in development. One's awareness of the moment leads into another. James' 'Stream of Consciousness' illustrates this action. Awareness, according to James (1890), is always in flux, but there is a sequential flow, for which there is cause and effect. The 'Stream' is made up of smaller streams and there are cross currents. Each smaller stream is a unitary sequence of sensitivities. Attention is a term designating those streams occupying the focus of the 'Stream of Consciousness'. Intent is a term designating the stimulus. The focusing of any awareness may be short or long in duration and focal awarenesses of an earlier moment may drop deep into the channel of near-conscious activity. But they may return again to focus at a later period. Or they may take their place as unconscious activity. The *unconscious* is awareness of the past which is difficult to recall in other than very sketchy dimensions.

B. Successive Awarenesses

Successive awarenesses correspond to successive reactions and one of the tasks of the psychologist has been to correlate these two aspects of psychological activity. The simultaneous pattern reaction, which is a hypothetical unit of behavior, has a corresponding unit in awareness. A simultaneous awareness is a hypothetical existence, except in reports of immediate sensitivities, such as the taste of sweet or the smell of an odor. Awarenesses are always in development under the stimulation of intent. While a simultaneous awareness may be described, it is but a portion of a stream of successive awarenesses.

II. ATTENTION

Attention is a process of focalization of sensitivities in the awareness situation as it flows forward in development.

A. Stimuli of Attention

The stimuli of awarenesses are of both environmental (immediate sensitivities) and conscious (recalled sensitivities) origin. These stimuli are called intents.

B. Development of Attention

Genetically, the focusing of attention develops through three stages: primary, secondary, and derived primary attention (Titchener, 1896).

1. PRIMARY. In primary attention the awareness is determined by any environmental stimulus which is biologically powerful enough.

2. SECONDARY. In secondary attention there is conflict of awarenesses with any one focusing only for a moment.

3. DERIVED PRIMARY. In derived primary attention a configuration of sensitivities (immediate and recalled) has overcome the opposition of others and is focused with considerable duration. This is the awareness situation when an individual is said to be interested in his task.

C. Titchener's Seven Laws of Attention

Titchener (1908) gives seven laws describing the process of attention in the awareness situation.

1. The awarenesses attended to become clearer and more distinct; the awarenesses attended from are rendered less clear and distinct.

2. Under certain conditions, the awarenesses attended to become more intense as well as more clear and distinct.

3. Under certain conditions, the awarenesses attended to become more durable, as well as more clear and distinct.

4. There are never more than two degrees of clearness and permanence observable in the awarenesses of a given moment. The difference is maximal in the case of 'absorbed' attention, minimal in that of 'roving' attention.

5. The state of attention is of comparatively short duration; or, as it is usually put, the attention fluctuates.

6. The awarenesses attended to cannot exceed a certain proportion of the awarenesses constituting the total awarenesses of a given moment; or, as it is usually put, the range of attention is limited.

7. The awareness attended to rises more quickly than other awarenesses stimulated simultaneously with it.

III. TASK AND INTENT

Sensitivities and recalled sensitivities form what has been called the structures of awareness. The structures of intent are reported in introspections as sensitivities and recalled sensitivities. In the observation of the course of awareness it is noted that there is an oscillation between the awarensses of the *task* and the awarenesses of why and how to do the task, which are called *intent*. This division of awarenesses is necessary to an understanding of action and thinking. In a dynamic psychology the experimenter is concerned with causes. The distinction between the awarenesses of intent and of task is not necessary to a study of structures.

A. Task

A simple task may be one of immediate sensitivities or recalled sensitivities. But where a rose is presented for smelling, or a chord is sounded for hearing, there is an intent to smell, or to hear, although one often thinks of this awareness situation as a sensitivity determined by the environmental stimulus. All sensitivities are awareness actions involving an intent to observe, or a near-conscious counterpart of this intent.

B. Intent

The intent may be one to observe, to work, to learn, and so on. It is the driving stimulus of the awareness situation. The awareness situation in action, such as in performing mental and physical work, includes awarenesses of the task and awarenesses of intent to perform the task. There is an oscillation in clearness of these sensitivities, or of the focus of attention between these two structural aspects of the awareness situation.

IV. CLASSIFICATION OF INTENT

A classification of intent, or driving stimulation in awareness, follows.

A. Intent (German Term, Aufgabe)

Intent is a very focal awareness operating as the stimulus to later awarenesses. It is described often in introspection as a goal. It may involve a plan of work, including minor goals as well as methods of accomplishment.

B. The Mental Set (German Term, Einstellung)

The mental set (motor set) is near-conscious intent, which is the stimulus to most psychological activity. The goal is not very clear to the individual reporting his awarenesses, but there is a clearly describable motor set, which is reported as a kinesthetic structure. In the emotional set, which is a special form of the mental set, the awareness situation is congested and its structure unclear.

C. Determining Tendency (Woodworth's 'Activity in Progress')

The determining tendency is the mental set after the activity is in progress. It is the driving stimulus observed in awareness. Sometimes the individual is unaware of what he wishes to do. He reports that he "just keeps doing it", which is a common report in 'automatic activity.'

The mental set and the determining tendency are genetically older developments of intent. The 'wish', 'need', and 'desire' are determining tendencies.

V. THE GENETIC DEVELOPMENT OF INTENT IN EXPERIMENT

The development of intent is often studied in the fore-period of the instruction, mid-period of the plan, and after-period of resolving of intent. This division is used for experimental purposes.

A. Fore-period of Instruction

When instructions to perform any activity are administered, assuming that there is awareness of these instructions by the individual, an intent may be developed to follow the instructions, or the awareness of them may be only momentary and there is a rejection of instructions.

1. 'New' Intent. Each 'new' experimental intent is the product of instructions (immediate sensitivity), but it is also the product of a background of intent, mental set, and determining tendency, some of which may reach far back into the individual's adjustments to similar situations in early life. Such is true of all intents, whether in the laboratory or in practical everyday affairs.

2. Individual Differences. There are differences between individuals in the acceptance of instructions, showing the influence of past intents. These differences are evident where reactions of accomplishment are correlated with intent. The differences observed between individuals in educational and industrial tasks are products not only of capacity to do these tasks but intent to accomplish them.

B. Mid-period of Plan

The intent is always in process of development. Sensitivities (correlated with environmental stimuli) and recalled awarenesses, such as plans of performance in similar tasks in the past, influence the development of intent in the same manner that intent was developed in the fore-period.

1. Description of Intent. There is usually less detailed awareness of intent in the mid-period of the task. Often, intent takes the form of a mental set to do the task, and the observer finds difficulty in describing it.

2. The Development of Intent. The intent is frequently revised in the mid-period. Reports of intent during this period show that the plan of work is always changing and that any new awareness may influence its development. New instructions, similar to those of the fore-period, cause an increased awareness of intent.

C. After-period of Resolving Intent

Intent is resolved in awareness, following the consummatory awareness of the task which achieves the final goal.

1. Mental Set. By this time stimulation is usually in the form of a mental or motor set (*Einstellung*). The development of intent in long continued successive awarenesses, providing there are few awarenesses influencing its development, is always in the direction of less and less clearness of its structure.

2. Increased Focalization. But awareness of intent may be increased at this time in the checking of the consummation of the successive awareness with its guiding plan and goal.

3. Resolving of Intent. The intent of one successive awareness is resolved into intents to perform other tasks. Its influence is observed in later psychological activity.

VI. RELATIONSHIP OF ENVIRONMENTAL STIMULUS, INTENT, AND REACTION

The experimental aim of most investigations of intent is to trace development over a period of time and to compare the changes in intent with changes in environmental stimuli and reactions.

A. Relation of Stimulus and Intent

A relationship exists between the environmental stimulus and the intent, but it is not a one-to-one relation. Past intents in similar tasks contribute to the intent which is developing. There may be (1) an acceptance of the new awareness of instructions, or (2) a rejection. In either case this is caused by mental set. Under (1), the acceptance of new instructions, introspection shows a verbalization,

or partial verbalization, of "I will do it", or a motor (kinesthetic) set to do it. Under (2) there is similarly a verbalization or partial verbalization of, "I will not do it", or "I will work as I have been doing", etc., or kinesthetic sets to continue the task as before. Awareness of any change in environment is accepted or rejected into the plan of the intent. Present mental set determines this. Awareness of an environmental change does not necessitate a development of intent in relation to it. This is illustrated in situations where work is being performed under conditions of distraction. The distraction stimulus, of which the worker is aware, does not necessarily influence the intent of the worker. Also, there appears to be no unconscious influence of changing environmental stimuli upon the intent, although this is a debatable point.

B. Relation of Stimulus and Reaction

There is not a one-to-one relation between the environmental stimulus and reaction. Prediction of reaction, as is done in mental measurement and in behavior studies, is in terms of probability which allow for motivation influences other than those of the controlled environmental stimulus. This is well known in objective studies.

C. Relation of Intent and Reaction

There is a close relationship between intent and reaction. How close this is, is undetermined because of inexactness in the quantitative measures of intent. Theoretically, the relationship should be perfect for possible tasks. Changes of accomplishment in experimental situations correlate closer with changes in intent than with changes in environmental stimulus. Awareness of an environmental change does not necessarily constitute an influence upon reaction. The worker is aware of a variety of such changes, but these awarenesses do not affect the reaction unless they form part of the intent. There appears to be no unconscious influence of stimulus upon reaction, other than of a physical sort.

VII. PHENOMENA OF INTENT AND MENTAL SET

In 1889 Müller and Schumann showed that a motor predisposition (*Einstellung*), determines the subject's judgment in lifted weights. An 876 gram weight, following the lifting of a 676 gram weight, was judged lighter, when preceded by practice with a 2476 gram weight in place of the 876 gram weight. The 876 gram weight went upward more quickly as objective evidence of mental set. The method used in this experiment has formed the basis of numerous investigations upon intent and mental set.

A. Sensory-motor Attitude in Reaction Time

In 1893 Kulpe concluded that the preceding state of consciousness is important in all reaction-time experiments. In reaction-time ex-

periments intent is focused upon some part of the continuum of events from stimulus to reaction. When focused upon the environmental stimulus (sensory reaction) the reaction time is lengthened and when focused upon the fingers and reaction key (motor reaction) the reaction time is shortened. For vision, sensory reactions average about 290 ms and motor reactions about 180 ms. For audition, the sensory reaction is about 225 ms and the motor reaction about 120 ms, while for the electrical stimulation of the skin the sensory reaction is about 210 ms and the motor reaction 105 ms (Titchener, 1896). Various complications of the intent likewise increase the reaction time as in the choice, free association, and controlled-association reaction. So the intent of the awareness situation is an essential causative factor in the reaction.

B. Conflicting Intents

In psychological activity, such as that in a choice reaction experiment, several intents oscillate in awareness. Ach devised a method in 1910 to measure the force of conflicting intents. First, observers learned pairs of nonsense syllables until they responded with the second syllable when the first was presented. Then, Ach instructed these observers to respond, not with the second syllable which they had learned, but with a syllable which rhymed with it. He found that observers would respond with the second syllable, contrary to new instructions to respond with a rhyme. He concluded that previously established associations tend to be reproduced, even when the intent is to respond with something else, because of the strength of the older tendency. Lewin contradicts this conclusion, however. He (1922) repeated the experiment exactly as performed by Ach. There was always a response with a rhyme, according to instructions. Lewin's conclusion is that the intent determined the reaction and that Ach had induced an intent to respond with the second syllable before a rhyme for it could be presented. In other words, the intent at the moment of response determined the reaction.

C. Strength of Unresolved Intent or Mental Set

A method, devised by Lewin, which has come into extensive experimental use for the measurement of strength of mental set (psychological tension), is to interrupt tasks in order to compare the recall (memory) of these uncompleted tasks with others which were completed. Zeigarnik (1927) showed that the uncompleted tasks are recalled in proportion of about two to one of the completed tasks $\left(\frac{\Sigma U}{\Sigma C} = 1.9.\right)$. Numerous investigators have verified this result, which indicates the relative strength of the unresolved intent or mental set. It has been shown that various conditions, such as fatigue and immediacy of recall, influence the strength of the unresolved intent.

D. The Effect of Environmental Stimulation on Intent

James (1890) believed that the essential causes of psychological activity are in awareness and numerous investigations into the motivat-

ing effect of distraction, reward, rivalry, and the like, imply that this is true. Fryer (1934) showed that rhythmic auditory stimulation accompanying mental work may or may not influence intent. Previous intents, or mental sets determine any use made by the individual of environmental stimulation.

E. Intent and Accomplishment

The fact that accomplishment depends upon intent has been brought to light by numerous investigators. Külpe (1904) showed that specific parts of materials, which one intends to learn, are learned in proportion of 2:1 over other parts of the same learning material. Fryer (1934) showed that there are no significant changes in mental accomplishment without a co-existent development of intent. Intent determines what one observes, learns, or accomplishes.

VIII. INTENT AND THOUGHT

Numerous investigators during the first decade of the century came to the conclusion that the sequence of awarenesses, called thought, and the final result of thinking, called judgment, decision, choice or conclusion, were determined by intent. Watt (1904) showed that intent (*aufgabe*) transforms into judgments a sequence of awarenesses. The 'idea of end' determines the sequence of awarenesses (Ach, 1905). Fisher (1916) brought out the fact that the direction of the conscious process of generalizing abstraction lies in the intent. Wheeler (1920) showed that a determining tendency set up to choose is a series of anticipatory (incipient) motor adjustments, which was started by the motor response of accepting the intent (given in the instructions) to choose.

A. Logical Thinking

All successive awarenesses are directed by a goal. This is called logical thinking. The goal is defined in various degrees of clearness in intent. Recently, in animal psychology, Tolman (1932) has shown that rats with the same physiological drive (hunger) but with different food in the goal box, exhibit different rates of learning. This is due to different goals ('cognitive expectations'). A high degree of specificity of the goal characterizes all logical thinking.

B. Dreams

The difference between logical thinking and dreams is one of intent. The intent of the dream is less clear and can best be described as a determining tendency. Psycho-analysis characterizes it as the 'wish.' 'Creative imagination' may often be similar to dreams with no definite goal; it is often exploratory and under the guidance of a determining tendency.

C. Reasoning and Generalizing

The concept, the judgment, and the choice are goals of intent. Reasoning and generalizing are successive awarenesses directed towards a goal with an intent that is usually very clear in its dimensions.

D. Thinking

Thinking is any sequence of directed awarenesses. The directing process is the intent, or its less conscious counterparts, the mental set or determining tendency.

IX. THEORIES OF PSYCHOLOGICAL ACTIVITY

Various theoretical explanations of psychological activity, in particular as awareness is involved, will be discussed in this section.

A. The Locale of Awareness

Where does awareness (consciousness) exist? There have been many attempts to answer this question. The brain was accepted early in the history of psychology as the locale of awareness, but contemporary psychologists are more inclined to regard consciousness as a function of the entire nervous system and even of the musculature of the body. Leading theories follow.

1. Sensory Theory. According to this theory the integration of psychological activity (involving meaning) is primarily sensory. Consciousness is an aspect of nervous integration which is determined by the organization of receptors and sensory areas of the brain. It is a function of the nervous system at a stage when nervous activity is in the process of correlation and before it passes over into coordination of effectors.

2. Motor Theory. In this theory awareness is regarded as primarily motor. It is an aspect of final action in the process of nervous integration which takes place in the reaction of effectors. This theory postulates an implicit pattern reaction for each pattern awareness, while the sensory theory does not. According to the motor theory, awarenesses are verbal, muscular, and glandular reactions not expressed in overt activity. Thinking is implicit reaction. Consciousness exists in minute reactions of effectors.

3. Central Theory (Theory of Brain Reactions.) Awarenesses are reactions of the central nervous system, particularly of the cerebrum, which take place independently of afferent or efferent nerves, but may finally culminate in action of effectors.

All three of these theories are accepted by leading psychologists today. The central theory, however, has the least scientific support. Any one of the theories recognizes a series of psychological events carried on within the organism and observable in the activities of awareness and of the nervous system.

B. Theory of Stimulation

While an experimental definition of stimulus describes it as something specific in the environment affecting an organism, such as a certain brightness or pain, the true stimulus for an organism is a total situation in which various specific factors have an integrated effect. Often, this stimulating situation is defined as affecting receptors, but where possible it is defined in awareness, as intent, where contributing to the total stimulating situation is the mental set of past experience. Occasionally the effect of past experience in the stimulating situation is defined in terms of the nerve impulse, or it may be defined in terms of reaction, as in animal studies. The stimulating situation affecting an organism at any one time includes the observed changes in the environment along with effects of maturation and past integrations. Usually the stimulating situation involves some core or goal which cannot be eliminated by one or several reactions. This is defined as the driving stimulus of the organism.

C. Theory of Sensitivity

Sensitivity is correlated with stimulus and receptor excitation and these factors are involved in the explanations of sensitivity along with those of nerve organization and discharge of impulse.

1. Intensity of Sensitivity. Generally speaking intensity of sensitivity is correlated with the energy of the stimulus. The intensity of the visual and auditory sensitivities is a function of the amplitude of the waves. For other departments of sensitivity the correlation is not so clear and the intensities of the awarenesses are said to be due to 'more' or 'less' of the stimuli. As an exception to this rule, in audition and vision the intensity of sensitivity is found to be affected by stimulus frequency as well as stimulus energy.

a. *Receptor Theory of Intensity.* Different cells of a receptor vary in their absolute threshold and the assumption is made that intensity of sensitivities depends upon the number of receptors stimulated. Stimuli having high energy values spread and activate a larger number of receptors than do stimuli of lower energy values.

b. *Nerve Theory of Intensity.* Two general principles of nerve action are involved in a neural explanation of intensity of sensitivity: (1) *the multiple fiber principle,* which states that stimuli of greater amplitude cause the excitation of a greater number of nerve fibers through the increased number of receptor cells affected; and (2) *the frequency principle,* which states that stimuli of greater amplitude cause a greater frequency of discharge of nerve impulse in the neuron. The all-or-none law established the fact that a neuron once activated is independent of the energy of the stimulus, but stimuli having different energy values cause different frequencies of discharge of the impulse. Also, neurons differ in their capacity for frequency of discharge. The

frequency theory attributes intensity of the sensitivity to the number of impulses in a unit of time. However, according to the membrane theory of nerve action the capacity of a neuron for discharge is limited to a rate of not more than 1000 a second for man, a rate which is lower than that necessary for the intensity differences in various departments of sensitivity. The *Volley Theory* (Wever and Bray, 1930) combines the frequency and multiple fiber principles in an explanation of the intensity of sensitivity. As the stimulus energy increases, the frequency of impulse in any one neuron increases, or the number of neurons activated increases, or both, and the total frequency of impulses at any one moment accounts for the intensity of sensitivity. Hence, intensity of sensitivity is comparable to the frequency of the nerve impulse.

2. Visual Sensitivity. Visual sensitivity consists of light and color vision, which is caused by achromatic and chromatic stimulation.

a. *The Duplicity Theory.* Von Kries (1894) postulated two sensitivity differences in the receptors of the retina: light sensitivity from the rods, which are activated by achromatic stimuli, and color sensitivity from the cones, which are activated by chromatic stimuli. The duplicity theory is supported by the facts differentiating rod and cone vision and it has general scientific acceptance.

b. *Theory of Achromatic Sensitivity.* Achromatic sensitivity is a photo-chemical process in the retina. The rods contain a sensitive substance, known as rhodopsin or visual purple, which is unstable in the presence of radiant energy. Light waves impinging on the retina cause a chemical reaction in the light-sensitive substance of the rods and during a process of decomposition give rise to visual awareness at some later stage as a function of nerve action. A reversable chemical reaction sets in upon the removal of the stimulus giving rise to after-images as a part of the metabolic process.

c. *Theories of Chromatic Sensitivity (Color Vision).* As early as 1801 Thomas Young had formulated a theory to account for color sensitivity. This theory was extended by Helmholtz (1852) and is now known as the Young-Helmholtz theory. According to this theory there are three distinct kinds of photo-sensitive cells in the retina, each of which differs in receptivity of different wave lengths. For one kind of cells, sensitivity is greatest in the red bands of the spectrum, for another in the green bands, and for the third in the blues (violet). The different color sensitivities are due to the stimulation of all cells but with different intensities. Absence of external stimuli, and consequently absence of excitation in any of the cells results in an awareness of black. Mixture of red and green stimuli produces an awareness of yellow; mixture of yellow and blue gives an awareness of white (at some level of brilliance on the black-white continuum); and mixture of red, green, and blue also gives awareness of white. Thus there are

three kinds of receptors, which when properly stimulated will give rise to awarenesses of all the colors including black and white.

Hering (1878), also, postulated the existence of three different retinal substances, but each when activated can cause two visual sensitivities. One substance reacts to red or green, a second to blue or yellow, and the third to black or white. Anabolic activity in the substances results in awareness of green, blue, and black while katabolic activity produces red, yellow, and white. The white substance is stimulated by all photo-stimuli while awareness of black is due to the normal anabolic activity in the substance in the absence of external stimulation. Each of the other substances is stimulated only by a limited range of wave lengths.

Ladd-Franklin (1924) proposed an evolutionary theory to combine certain features of the preceding theories. She posits a primitive photochemical substance which is activated by any photo-stimulus, and which originated in the rods of the primitive eye. The possessor of such an eye would have awarenesses of the black-white continuum only. From this primitive substance a new substance has evolved which is activated by stimuli for blue and yellow. The yellow-sensitive element further evolved to become sensitive to reds and greens. Stimulation of the red-green element causes decomposition and upon recombination the yellow substance is formed and an awareness of yellow follows. If the blue element is also stimulated, the blue and yellow elements recombine to give the gray element and the resulting awareness is of white or gray. Black is due to the simple vital activity of any or all of the elements.

Each of these theories stresses some aspects of the visual process. In the Young-Helmholtz theory the independence of the three elemental hues: red, green, and blue, is emphasized. In the Hering theory the phenomena of monocular color mixture, antagonistic and complementary colors, and negative after-images are emphasized. The Ladd-Franklin theory ignores many of the phenomena of binocular color mixture. Hecht (1928) stimulated the retina of one eye with red and the corresponding retinal area of the other eye with green. The resulting awareness was of yellow. This phenomenon is unexplained by any but the Young-Helmholtz theory which is favored today by most psychologists working in the field of color vision.

3. Auditory Sensitivity. Auditory sensitivity is explained as due to central analysis of sound in the brain or peripheral analysis as a function of the receptor mechanism. Rutherford's telephone theory (1887) assumes that the different fibers of the auditory nerve act as a telephone circuit when stimulated by the structures of the inner ear and the analysis of the sound is a central function. But most psychologists, today, accept some peripheral explanation of auditory sensitivity. Ewald (1899) and Meyer (1907) explain hearing as of peripheral origin. Ewald developed the *sound pattern theory* in which any com-

plex sound wave is reproduced exactly on the basilar membrane through different vibrations of its segments, causing differences in auditory pitch and intensity. Ewald demonstrated this theory with an artificial membrane composed of rubber. In a *displacement theory,* Max Meyer attributes auditory analysis to the displacement of the basilar membrane as a whole. Pitch is due to frequencies of displacement and intensity to amount of displacement, and the resulting frequency and number of nerve impulse.

Resonance theories have attributed analysis of pitch and other dimensions of tone to the rods of Corti, the hair cells, the tectorial membrane, the basilar membrane, and to all of these structures together. Helmholtz (1877) explained pitch as due to the sympathetic vibrations of the 24,000 fibers of varying lengths in the basilar membrane, which are mechanically stimulated by the ear mechanism. Helmholtz's *resonance (harp) theory,* with various modifications, is widely accepted as conforming to most of the known conditions of auditory sensitivity. The fibers of the basilar membrane are three times as long at the apex as at the base. It is assumed that different tensions are produced by the ligament, which is larger at the base. Also the rods of Corti, weighting the fibers of the basilar membrane, are largest at the apex. Thus, a sufficiently wide range of sympathetic resonators is believed to exist for the reproduction of all sound stimulation within the range of hearing. A given clang, with its overtones, may involve a broad band of the basilar membrane, but in general high tones are attributed to the basal region and low tones, with less certainty, to the apex of the cochlea.

Wever and Bray (1930) have added to the resonance theory an explanation of pitch differences in frequency of nerve impulse. At a relatively slow frequency a nerve fiber may respond to each vibration of a fiber of the basilar membrane, but as the vibrations of the basilar membrane are increased in frequency several nerve fibers are activated in successive order and the frequency of the stimulus is represented in the total of nerve impulses at any one moment.

4. Gustatory and Olfactory Sensitivities. Gustatory and olfactory qualities are believed to be correlated with specific differentiated receptors for each quality. Four qualities in taste are recognized but there is insufficient evidence to say whether or not there are individual taste-buds for these qualities. It is usually assumed that there are separate nerve paths for the four qualities of taste but there is little neurological proof of this. Even less is known of olfaction as a basis of theory. The number of elemental qualities has been variously estimated. Henning (1916) has segregated six elemental qualities while Zwardenacher (1895) had decided upon nine. Any correlation which may exist between the specific qualities and the olfactory cells is unknown.

5. Theory of Equilibrium Sensitivity. Equilibrium sensitivity is explained as due to the stimulation of the crista of the ampullae by movement of the endolymph in the semicircular canals, and by the stimulation of the maculae by the movement of the otoliths in the vestibular sacs. The nerve endings in the ampullae and the maculae form the vestibular branch of the auditory nerve and impulse is relayed directly to the cerebellum to which is attributed the unconscious function of equilibrium.

6. The Cutaneous, Kinesthetic, and Organic Sensitivities. Two theoretical points of view exist in the explanation of these sensitivities: (1) That there are special differentiated receptors for the four qualities of pressure, pain, warmth and cold, and (2) that sensitivity of surface linings is unspecialized in reception and the so-called qualities are quantitative differences in intensity. While correlations between the receptor and sensitivity are undetermined, the localization of the sensitivity in relation to the stimulus is exact for the four qualities in the cutaneous surfaces, with some degree of exactness in the linings of the alimentary tract, and more vague localizations in the linings of the joints and muscles. Nerve tracts to the somesthetic area of the cortex have been distinguished for the cutaneous (exteroceptive) sensitivities and the kinesthetic (proprioceptive) sensitivities.

a. *Cutaneous Pressure and Pain Gradient Theory.* Stimulation of pressure is by gradient deformation of the cutaneous surface. This theory accounts for various pressures as the resultant of the pitch and rate of formation of the gradient, which is caused by the weight, size, and movement of the stimulus. Stimulation of pain is due to rupture of the free nerve endings occurring when a steep pressure gradient is formed.

b. *Cutaneous Temperature Gradient Theory.* A gradient theory also fits most of the facts of cutaneous temperature sensitivity. When the normal outward flow of heat from the body is changed there is temperature sensitivity. When a negative gradient or abnormal outward flow of heat obtains there is cold sensitivity. When a positive gradient or abnormal inward flow of heat obtains there is warmth sensitivity. The intensity of sensitivity is accounted for by the steepness of the gradient.

D. Theory of Sensitivity Integration

Sensitivity integration involves all exteroceptive sensitivities of the explicit environment, intero-and proprioceptive sensitivities of the implicit environment and the functional effect of past sensitivities whether in terms of detailed recall (images) or mental set. Sensitivities would not be integrated into meaningful wholes without the effects upon the organism of past experience.

1. Theory of Explicit Extensity Sensitivity. A mass of facts has been collected concerning the exteroceptive cues of extensity sen-

sitivity, and particularly those of vision, which were reviewed in Chapter XII. The integration of these cues into space sensitivity is unconscious to a high degree in the normal adult, as instanced in steroscopy, in viewing a painting, in holding a large bundle in the arms, in listening to an automobile pass on the street, and so on. Essential to all space sensitivity of the explicit environment, however, are the postural cues of equilibrium and kinesthesis. *All* explicit extensity is in relation to the body, just as is all implicit extensity. Coordination of exteroceptive cues and kinesthetic cues in explicit extensity must be attributed to the effect on the organism of past sensitivity and its recall in terms of function, with resulting orientation of the organism as a unit in its environment.

2. Theory of Implicit Sensitivity. Implicit sensitivity is not unrelated to explicit sensitivity, but intent or mental set often unifies implicit sensitivities of organic pressure, pain, and temperature complexes in a way not often experienced in explicit sensitivities. P-U is essentially implicit and focal under varying health conditions. Implicit extensity sensitivities, while diffused, are focal in awareness. They are in ascendency over explicit sensitivities under such conditions as the autonomic functions, disease, old age, and abnormality.

3. Movement Sensitivity. Movement is temporal and extensity sensitivity, in which definite conditions of stimulation of successive events are present, whether it be movement of the body or objects external to the body. Extero-and proprioceptive cues in relation to past experience are essential to the integration.

Sensitivity integrates, based on past sensitivities, according to the capacity (intelligence) of the organism. Measures of learning indicate development in sensitivity to higher levels of accuracy in relation to physical measures. Sensitivity is a measure, or group of measures, of the environment, which always grows in constancy, whether toward accuracy or inaccuracy in relation to physical measures. Its dimensions are correlated with physical measures in varying degrees, but always it is necessary to regard sensitivity as a psychological view of the environment unlike in degrees of detail and integration to the results of physical measurement.

E. Theories of Acting and Thinking (Successive Activity)

Both acting and thinking are successive activity and are described and measured in relation to a goal. Their chief distinction is in terms of amount of detail of conscious structures. Acting is generally less conscious than thinking but the degree of consciousness in each is relative. Usually, acting is distinguished from thinking because it is investigated in reaction while thinking is studied in awareness. In the motor theory of thought, thinking is implicit reaction in some form

or other; thus pattern awarenesses and pattern reactions may be structurely alike. The degree to which this is true is not known, but it is probable that acting and thinking are functionally similar.

1. Essentials to Acting and Thinking. The following are always present in various degrees of detail or clearness in thinking and in ideamotor activity (acting involving consciousness):

(a) There is a goal.
(b) There is a task.
(c) There is an intent to reach the goal by accomplishing the task.
(d) There are intermediary goals and tasks, and intents to reach the intermediary goals by accomplishing the intermediary tasks.

Such successive activity is studied in behavior, as in animal learning, or in awareness and behavior combined, as in language activity, or in awareness alone, as in abstract and symbolic thinking. Neither motor nor language reactions are essential to this activity, although much successive activity involves them. Also, recalled sensitivities (images) are not necessary, as when acting (and thinking) progresses as a determining tendency. Essential to acting and thinking is progress in a task toward a goal determined in intent or in an unconscious development of intent, called mental set.

2. Creative Thinking. All acting and thinking is explained in this manner except creative thinking (and acting), where the organism reaches the goal without successive activity as a reproduction of past development (learning). *Insight,* which is a sudden awareness of the solution of the task and the reaching of the goal, is introduced as the explanation of creative thinking. Mechanical trial-and-error activity might never reach the goal in a new situation and many goals, or intermediary goals, are attained by a sudden flash of insight. Insight, however, is but a part of directed trial-and-error (by intent) and the 'insight flashes' are from past experience.

All psychological activity can be thought of as acting and thinking. Pattern awarenesses and pattern reactions are but structural units in successive activity which are accepted or rejected in relation to the goal under the direction of intent or mental set.

INDEX OF NAMES

See page 223 for general Index

INDEX OF SUBJECTS

OBJECTIVE EXAMINATIONS

A student is interested in determining quantitatively his mastery of the subject matter of psychology and in ascertaining his limitations. For these purposes a series of objective examinations have been prepared and are included in this section. These tests are based on the foregoing text and on the collateral readings. There are six examinations, two for each part of the book as follows:

PART A

TEST I FIFTY COMPLETION PROBLEMS ON PART A

TEST II ONE HUNDRED FIFTY TRUE-FALSE PROBLEMS ON PART A

PART B

TEST III ONE HUNDRED THIRTY TRUE-FALSE PROBLEMS ON PART B

TEST IV FIFTY MULTIPLE-CHOICE PROBLEMS ON PART B

PART C

TEST V FIFTY MULTIPLE CHOICE AND COMPLETION PROBLEMS ON PART C, Chapters X-XI

TEST VI ONE HUNDRED TRUE-FALSE PROBLEMS ON PART C, Chapters XII-XIV

Sample examinations are found in the introduction (pages 12-14).

Directions for Taking the Tests

Upon completion of the study of one of the three parts of the book, turn to the appropriate tests, remove them at their perforation, and read the directions carefully. The approximate time required for each test is indicated in the directions. To consult the answer keys before taking the examination defeats one's purpose in taking the tests. It is impossible to secure a fair estimate of one's achievement after looking at these answers.

Directions for Scoring the Tests

After you have answered all the problems in any test, select the appropriate scoring key and remove it from the book. The pages on which these scoring keys will be found are indicated at the end

of each test. Place the key over the test paper so that the numbers of the questions are in alignment with the number of the answers. Mark each incorrect or omitted answer by making a check ($\surd$) on the test paper. By folding the answer key properly, each column of the key will match the answer column on the corresponding page of the test. Note that in some cases more than one answer is acceptable and the possible answers are indicated on the key.

After the incorrect and omitted answers have been checked count the number of unchecked answers. The number of unchecked answers is the score for the test. This score should then be verified by counting the checked answers and subtracting from the number of problems in the test. This difference should equal your score.

Comparison of Scores with the Norms

These tests were administered to a group of sophomores enrolled in a course in general psychology. Their scores were tabulated and percentile scores computed, which may be used as norms to indicate levels of knowledge in general psychology. The pages upon which norms for the various tests will be found are indicated at the end of each test.

To compare your score with the norms, locate the score nearest to yours in the column marked SCORE. The table will then indicate what percent of the college sophomores made scores equal to or less than your score. For example, if your score on Test 1 is 34, then scores of 34 or less were secured by 70 percent of the sophomore group. Only 30 percent of the group made scores of more than 34.

Remedial Study

The ultimate purpose of any test is to indicate to the student the material which he has not mastered and upon which he needs more study. Examine the incorrect or omitted questions and study again the parts of the text and readings dealing with these topics.

TEST I

FIFTY COMPLETION PROBLEMS ON PART A

The number of words necessary to complete each statement and make it true is indicated by the figure in the parentheses. Write the word, or words, on the line at the right of each statement. There is no time limit, but the test should require about 40 minutes. The score is the number of correct answers filled in. The pages of this test are perforated and may be removed to facilitate use.

(1) integration is not present in the lowest forms of animal life. 1.

The motor end plate of the nerve fibre is in contact with the (2). 2.

The (2) contract and expand more rapidly under stimulation than do the other effectors. 3.

The major physiological system of integration in the human body is the (2). 4.

Muscles are of two kinds: (1) and (1). 5. 6.

The nerve fibre, the (3), and the (2) compose the neuro-muscular unit. 7. 8.

An effector is a number of specialized contractile or glandular (1) which function as a (1) in the reaction of an organism 9. 10.

Psychological stimulation is received by (1). 11.

Chemical integration is through the (2). 12

There are probably many (2) not within the range of any of our (1). 13. 14.

Specialized functions of protoplasm on the psychological level are (1), (1), (1), and (1). 15. 16. 17. 18.

Effectors are classified as (1) or (1) according to their action upon the environment. 19. 20.

Receptors of stomach-ache are called (1). 21.

The point at which the optic nerve enters the retina is called the (2). 22.

The symbol 0 represents the (1) in an experiment. 23.

In the human being the accessory apparatus of receptors for (1) and (1) are the most extensive of any of the departments of sensitivity. 24. 25.

The four elementary taste sensitivities are (2) and (2). 26. 27.

The temperature of the skin when the sensitivity is reported as indifferent is called the (2). 28.

The objective evidence of the activity of effectors is called (1). 29.

Receptors may be classified as follows: (1), (1), and (1). 30. 31. 32.

Accommodation is the function of the (1) of the eye. 33.

(2) are the receptors of taste. 34.

The probable receptors for cutaneous pain are (3). 35.

The (2) transmits vibrations from the middle ear to the cochlea. 36.

Decrease in sensitivity with continued stimulation is called (1). 37.

The (1) are cells which are most sensitive to low intensities of light. 38.

Hair bulbs are probable receptors of (2). 39.

A third tone, of definite pitch, called a (2) can often be heard when two tones are sounded together. 40.

The lowest audible tone has a stimulus frequency of about (1) dv. per second. 41.

Quantitative dimensions existing for all sensitivities are (1), (1), and (1). 42. 43. 44.

Three qualitative dimensions of visual sensitivities are (1), (1), and (1). 45. 46. 47.

Three qualitative dimensions of auditory sensitivities are (1), (1), and (1). 48. 49. 50.

SCORE
(Number of correct answers)

Scoring Key on Page xxix.

For interpretation of your score see Norms for Test I—Page xli.

Test II

TRUE—FALSE PROBLEMS ON PART A.

If a statement is true, print a T on the line at the left of the statement; if false print an F. If a statement is partly true and partly false mark it as if it were entirely false. There is no time limit, but the test should require about 70 minutes. The score is the number of statements correctly marked. Remove test pages to facilitate use.

1. From auditory intensity differences one may gain extensity of awareness.
2. The wave length for blue is greater than that for red or yellow.
3. Smooth muscle fibres are relatively slower in losing tension than are striated muscle fibres.
4. The timbre of a musical instrument is due to its overtones.
5. As compared with sweet, the forward part of the tongue is more sensitive to bitter.
6. Motion and change of position are easily perceived through at least four departments of sensitivity.
7. Pressure is more important than kinesthetic sensitivities in comparing the weights of objects.
8. Disliking a person at first sight is an example of a reflex.
9. The essential function of the choroid coat is to prevent light from filtering in through the walls of the eye-ball.
10. Only taste sensitivities are located on the tongue.
11. Of air vibrations having the same frequency, those with the greater amplitude give the louder auditory sensitivities.
12. The semi-circular canals are stimulated by rotary motions.
13. When a portion of the skin is adapted to a certain temperature, other temperatures feel neither warm nor cold.
14. That part of the retina which gives the clearest vision contains many cones but no rods.
15. A muscle fibre may be either partially or completely innervated.
16. Dead black is the absence of all visual sensitivities.
17. The rods, when dark adapted, respond to fainter light than do cones.
18. Muscle fibres may be innervated individually.
19. The complexity of the behavior is the essential difference between the instinct and the reflex.
20. The sensitive cells of a distance receptor are located on the exterior of the receptor where they are most exposed to the environmental stimuli.

21. Paradoxical cold is due to the response of the warmth receptors to cold stimuli.
22. Adaptation of sensitivities is most rapid in taste.
23. The sarcolemma is a thin covering of the muscle fibre.
24. The cochlea is the receptor for the equilibrium sensitivities.
25. Sugar, salt, vinegar, and coffee are all the stimuli necessary to produce the primary taste sensitivities.
26. Air vibrations having a frequency of 20,000 dv. are at the upper limit of auditory sensitivity in humans.
27. Taste receptors are activated only by dissolved substances.
28. Conditioned reactions cannot be established through the autonomic nervous system.
29. A reaction is always of the same magnitude as the stimulus which evoked it.
30. Twitmeyer was the first to produce conditioned reactions in the dog.
31. A hungry animal will traverse a greater distance in a maze than will one which has been well fed.
32. Intense punctuform stimuli are used in locating the pressure spots.
33. A dog can distinguish between a metronome beating 100 strokes per minute and one beating at the rate of 94 strokes.
34. Inhibition, as well as excitation, may be involved in conditioning.
35. Conditioned reactions cannot be established in lower forms such as snails and minnows.
36. Identical twins reared apart differ more, on the average, in physiological development than do children (siblings) of the same parents, reared under family conditions.
37. Nausea is a complex awareness including organic sensitivities localized in the throat.
38. Explicit reflexes which take place in the non-striated musculature are always caused by stimulation of interoceptors.
39. The threshold of kinesthetic sensitivity of movement in the joints is greater than 5 degrees.
40. There is very little human activity involving driving stimulation
41. All instincts are present at birth.
42. Man's conduct is determined more by native behavior tendencies than is the behavior of lower animals.
43. The integrative mechanism makes possible the connections between incoming and outgoing neural impulses.
44. The negative after-sensitivity can be used to determine the complementary of a given hue.
45. Since conditioning is a type of learning, it is confined to the cerebrospinal nervous system.
46. Reflexes are native neural bonds between receptors and effectors.
47. Pre-natal development of reactions is wholly in maturation
48. Changes in conscious intent influence reactions.

49. The difference between two adjacent notes on the piano is the smallest difference that can be discriminated by the human ear.
50. A conditioned reflex can be established, even if during the training period the reward is presented after the conditioned stimulus.
51. Maturation of reactions is completed at birth and any further development of the reaction is due to stimulation.
52. The achromatic visual sensitivities are blacks, whites, and grays.
53. The naturally effective stimulus often is referred to as the unconditioned stimulus.
54. In the evolutionary development of organisms the effectors appeared before the receptors.
55. The psycho-analytic 'wish' is a highly conscious intent.
56. The visual positive after-sensitivity appears after a very short interval following the removal of the stimulus.
57. Once a conditioned reaction has been established it remains permanently as part of the individual's response repertory.
58. Both hue and pitch are correlated with the frequency of the stimulus.
59. Most reflexes are subject to modification with environmental stimulation.
60. A conditioned reflex may be considered a native reflex.
61. A fundamental factor in conditioning a reflex is repetition.
62. As temperature is increased, above 33° C the sensitivity of warmth is present, under normal conditions, on the back of the hand.
63. Before air waves can affect the auditory nerve fibers they must give rise to vibrations of liquids.
64. Even if the bird-environment be changed, the young bird invariably has the song of its own species.
65. According to the most radical of the rebels against the traditional instinct doctrine, we do not learn to fear but learn what to fear.
66. Motion picture studies of the emotional reactions of children confirmed Watson's classification of original emotional reactions.
67. As a rule, less intense environmental stimulation produces weaker reflex activity.
68. A conditioned reaction cannot be eradicated by repetition of the conditioned stimulus alone.
69. Any individual reaction is in reality a reaction to all stimuli acting on the organism at the time.
70. Pavlov's technique for conditioning reflexes permits quantitative evaluations of various factors operating in the conditioning process.
71. Not all physical changes in the environment serve as stimuli for psychological activity.
72. Pavlov has shown that it is possible to develop an inhibition of an inhibition to a conditioned reflex.
73. Consummatory reactions are final pattern reactions in a series of successive reactions.
74. As a general rule, learned and inherited reactions are independent in development.

75. According to Mateer, feebleminded children are not conditioned as readily as youngsters with normal mental endowment.
76. Krasnogorski selected the eye-wink reflex as the reaction to be conditioned in his experiments.
77. No human adult reacts in a manner that is entirely native in its development.
78. Very bright colors and very dark colors are always low in saturation.
79. A muscular reaction stimulates receptors for the 'muscle sense' and may be the stimulus to a second reaction.
80. The Purkinje effect does not occur in the central area of the retina.
81. The reaction of a conditioned reaction is always conscious.
82. The simultaneous pattern reaction functions usually as a separate and distinct unit of behavior, as in the reflex.
83. Foreign people instinctively speak foreign languages.
84. According to the Young-Helmholtz theory of color vision there are only three elemental colors.
85. Moss found that the sex drive was the strongest of the physiological drives in rats.
86. High efficiency of reactions is not achieved without exercise under environmental stimulation.
87. Instinctive reactions are successive reactions.
88. Cason demonstrated that conditioning was possible in smooth muscles.
89. Warden showed that exploration, or the drive to activity, was one of the strongest drives in rats.
90. A drive is usually present in a complex stimulating situation.
91. When the indifferent stimulus appears first, with the unconditioned stimulus following immediately, we have the best experimental situation for establishing the conditioned reaction.
92. Instinctive reactions are successive reactions which have been organized largely as a result of heredity.
93. A third environmental stimulus, which has been discriminated by a dog in a conditioning experiment, can reenforce a second stimulus which is inhibiting the action of a conditioned stimulus to the reflex.
94. Social drives frequently can be defined in terms of conscious intent.
95. Intent is a term applied to physiological drives.
96. Instinctive tendencies can be modified.
97. Reactions can be classified with exactness into native and learned reactions by use of the criterion: 'appearance without opportunity for learning.'
98. Contrast effect in vision is illustrated when a small gray paper placed on a blue background appears slightly yellowish.
99. Instinct is adequately defined as "complex modes of reaction present in all members of a species."
00. Maturation develops certain capacities which produce reactions upon the occurrence of adequate specific stimuli.
01. Heredity and environment are both influences in mental development.

102. Anthropoids could speak a symbolic language if they were subjected to the proper environmental stimulation.
103. The tendency to be with others, or to desire the company of others, is called the gregarious instinct.
104. That the sex drive is the strongest in rats has been confirmed by Warden and his associates.
105. 'Conditioning' explains how emotional reactions to words may be established.
106. The mother's hereditary influences continue to affect the child until birth.
107. Some sensitivities are stimulated before birth.
108. Tones have definite pitches while true noises do not.
109. S-I-R means stimulation, impulses, and responses.
110. The psychological stimulus is always a total situation.
111. Integration is a peripheral process.
112. There are two parts of every receptor: sensitive cells and reacting cells
113. Sweat glands are endocrine glands.
114. The qualitative differences which arise from variations of the overtones are called differences in timbre.
115. Discrimination of intensity differences varies with the frequency of the tones and with the level of intensity.
116. The absolute thresholds of cold and warmth vary for different bodily areas.
117. Protensity describes the spatial characteristics of the sensitivity.
118. Each pure color quality is correlated with definite wave lengths.
119. The mixture of any two colors which are not complementary produces a color sensitivity of intermediate hue.
120. The non-periodic sound waves stimulate sensitivities of noise.
121. The specialized sensitive structure of audition is the tympanic membrane.
122. Of sound vibrations having the same amplitude, those having the lowest frequencies stimulate the greater volume quality.
123. Clangs are formed only of a fundamental and one overtone.
124. The number of beats per second is the sum of the frequencies of the two fundamentals.
125. Any sensitivity can vary in intensity.
126. Henning defines six elemental odor groups.
127. Difference tones are heard when beats number less than ten per second.
128. Intensity of olfaction is related to density of the stimuli.
129. The receptors for olfaction are located on the tongue and palate.
130. Intensities of gustatory sensitivities are related to the concentrations of the stimuli.

131. Extensity is an important dimension of gustatory sensitivities.

132. Qualitative differences in equilibrium sensitivities have been amply demonstrated.

133. Intensity and protensity are lacking as dimensions of the equilibrium sensitivities.

134. The skin is a general receptor equally sensitive to all cutaneous stimuli.

135. Cutaneous sensitivities are from proprioceptors.

136. Changes in muscular movements are sensed by means of exteroceptors.

137. Physiological fatigue of receptors is the same as adaptation.

138. The negative after-sensitivity of orange is blue-green in color.

139. *Conditioned reactions may be destroyed by either general or special* inhibitions.

140. Binaural is a term applied to the iris of the eye.

141. The blind spot is a common name for the fovea centralis.

142. The receptors for pain and for the chemical sensitivity of the skin are free nerve endings.

143. It is possible to stimulate the skin simultaneously at two points so close together that they cannot be discriminated as two points but only as one.

144. When two tones are sounded together a third tone, *corresponding* to one whose stimulus has the frequency of the sum of the two components, may be heard.

45. Practice tends to increase one's accuracy in discriminating pitches.

46. A sub-liminal salt stimulus applied to one side of the tongue is not sensed, but if a sugar stimulus is applied to the other side the salt will then be tasted. This is an example of adaptation.

47. The gustatory threshold for bitter is lower than for the other elemental tastes.

48. Adaptation is most rapid for pressure and least rapid in olfaction.

49. Wetness is a simple elemental cutaneous sensitivity.

50. The stimulus for sensitivities of hunger is the rhythmical contraction of the stomach walls when the stomach is empty.

.....SCORE
(Number of correct answers)

Scoring Key on Page xxxi.

For interpretation of your score see Norms for Test II—Page xli.

Test III

TRUE—FALSE PROBLEMS ON PART B

If a statement is true, print a T on the line at the left of the statement; if false print an F. If a statement is partly true and partly false mark it as if it were all false. There is no time limit, but the test should require approximately 60 minutes. The score is the number of correctly marked statements. Test pages may be removed from the book.

1. The brain of a highly skilled juggler cannot be distinguished from the brain of one entirely unskilled in manual acts.
2. Explanations of learning in terms of physiological changes in the nervous system are based only on theory.
3. According to Dunlap's *Beta Hypothesis*, if one simply performs an undesirable act a number of times it will disappear.
4. Learning is less efficient when the learner is not allowed to know the results of his efforts than when he has such knowledge.
5. Mere repetition is sufficient to produce efficient learning.
6. One may learn without making any overt response.
7. Both learned and unlearned reactions are functions of heredity.
8. Maladjustment is indicated often by unusual reactions in a normal environment.
9. From one's intelligence it is impossible to draw valid conclusions regarding his standing on other personality traits.
10. No learning will take place if there is no 'effect'.
11. Belongingness signifies a 'natural connection' between the stimulus and the reaction.
12. Maze experiments are restricted to children and animals.
13. All animals are capable of learning.
14. Trial-and-error behavior is unique to animals.
15. There is evidence of learning by animals, even when incorrect reactions are more frequent and more recent than correct reactions.
16. Overlapping of distributions of personality measures for different groups is commonly found.
17. Learning is the modification of behavior through experience.
18. There is a clear-cut distinction between learning and memory.
19. Animals do not display insight.
20. Insight is a special case of trial-and-success behavior.

21. Continued repetition of a reaction may make its occurrence less probable.
22. The process of learning may involve reacting in one way to a stimulus and later reacting in a different way to the same stimulus.
23. People with extremely vivid and lasting imagery are called introverts.
24. Individual learning curves show a gradual and regular decrease in the number of errors made per trial.
25. Watson found that rats deprived of vision could not learn to run a maze.
26. Frequency and recency adequately describe how learning occurs
27. The frequency theory requires that reactions which are correct occur more often than incorrect reactions.
28. An adequate theory of learning should explain all modifications of psychological activity.
29. According to the law of exercise, repetition weakens the mechanism responsible for a response.
30. The law of effect states that a reaction is 'stamped in' by what takes place before the reaction is made.
31. Learning is purposive activity.
32. General paralysis (paresis) is a kind of insanity related to extreme introversion.
33. The 'physiological limit' is reached when the individual becomes sexually mature.
34. The zero point of learning is the beginning point of all experiments on learning.
35. Evidence, in general, indicates superiority of the whole method over the part method of learning.
36. Plateaus universally characterize human learning curves.
37. The curve of forgetting, where there is little overlearning, indicates that most of our forgetting takes place very soon after learning
38. Distribution of learning refers to cooperation among learners in which each learns part.
39. In general, it may be said that spaced study is superior to unspaced as far as time spent in learning is concerned.
40. Introverts are typically daydreamers.
41. As learning continues, more and more is accomplished in each succeeding practice period.
42. Transfer of training refers to the carrying over of learning from one situation to more or less related situations.
43. Transfer of training is due to training of special mental capacities
44. In so far as identical elements occur in different acts, to that extent will there be transfer of training from one to another.
45. Active learning is present in learning to skate.
46. Passive learning, in general, is superior to recitation in learning.
47. Temper tantrums are due to inherited emotional instability.
48. The law of readiness is an attempt to explain the law of effect.

49. The phrase 'other things being equal' in laws of learning means that whenever the law operates, other things are equal.
50. Learning is most efficient when practice is concentrated in one period.
51. Mnemonic devices, on the whole, are worthy of universal application.
52. Learning capacity does not decrease after about age 25 but continues without change to about 45 when it gradually decreases.
53. Many laws which apply to learning apply conversely to forgetting.
54. Glandular secretions cannot be conditioned.
55. Conditioned reactions are always formed under conscious motivation.
56. According to Adler feelings of inferiority are the most important motivators of behavior.
57. Loss of memory following a shock is called synesthesia.
58. Loss of memory following a shock is always for events immediately preceding the shock.
59. Glandular disorders may cause remarkable changes in the personality.
60. Chemical explanations of personality have been confined largely to specific personality qualities.
61. An individual who ranks a 50 percentile in introversion is an introvert 50% of the time and an extrovert the other 50%.
62. People who spend too much time day-dreaming are called ambiverts.
63. Self-ratings on personality traits are usually favorably inaccurate.
64. The 'halo effect' tends to cause ratings on different personality traits to cluster around the favorable extreme.
65. The whole personality changes markedly from one hour to the next.
66. The best method for unconditioning a fear response is to condition a new and appropriate response to the fear sumulus.
67. Neurotic tendency always causes abnormal sexual behavior.
68. All persons who score above 10 percentile in personality traits should have psychiatric treatment.
69. Fifty percent of people are introverted and fifty percent are extroverted.
70. Attitudes vary markedly between different cultural groups.
71. James of the James-Lange theory emphasized the visceral basis of emotion.
72. Sherman's experiment with emotional expression proves that there are no original emotions as Watson supposed.
73. Facial expressions are predictive of emotional behavior.
74. Watson's three primary emotions are generally used as examples of complex native reactions.
75. Integration refers to consciousness as well as to nervous activity.
76. Fear of the dark is an example of conditioning.
77. Emotion may be considered synonomous with feeling.

78. Objective measures tell us what an emotion is.
79. An 'emotional state' can be produced in an individual by injection of adrenalin.
80. Once the emotions are adequately classified we will know what they really are.
81. Emotion is disintegrative.
82. Emotional maturity refers to whether an individual has experienced all the emotions life offers.
83. A lie detector suggests that an individual is guilty by showing that he is in an emotional state.
84. Instinctive behavior is composed of highly complex successive pattern reactions which are disintegrative in their relation to adjustments.
85. If an individual is making the overt response of escape from danger, he must be experiencing the emotion of fear.
86. A mood may be defined as the after-effect of an emotion.
87. According to the James-Lange Theory, the emotion of fear is composed of sensitivities produced by the motor activity of fear.
88. As long as an incentive is present, satisfaction of the drive does not interfere with the strength of the incentive.
89. The evidence is conclusive that praise is superior to reproof with all children.
90. According to Kretschmer the ideal physical type is the 'pyknik'.
91. Experimental results on social facilitation demonstrate that one accomplishes more by doing 'home work' at home than in class.
92. War propaganda is an example of motivation by appealing to the emotions.
93. In our present day society motivation may be best considered in purely physiological terms.
94. Tissue conditions are motivating stimuli.
95. Habits may be motives.
96. 'Social facilitation' is motivation due to competition.
97. Acquisition is the first genetic stage of memory.
98. The two-factor theory conceives of intelligence as general ability and specific abilities in various fields.
99. Reliability refers to the reputation which a test has achieved from being given thousands of times.
100. Achievement Tests are used usually to predict school ability or disability.
101. If one takes an intelligence test when he is hungry he will make a lower score than if he had taken the test just after dinner.
102. By careful training all but the lowest idiots can learn to make an I. Q. of 100.
103. According to the theory of Stern individuals may differ in general intelligence and in special intelligence.
104. The study of the Kallikak Family indicates the influence of environment on intelligence.

105. Knowing the I. Q. of a child at age 3, his M. A. at age 6 can be predicted with considerable accuracy.
106. The emotions of infants can be accurately classified by experts by studying cinema records of their reactions.
107. Abnormality is always a matter of degree in its measurement.
108. Genius and feeblemindedness differ quantitatively rather than qualitatively.
109. A child who has an I. Q. of 120 has an M. A. of 6. His brother, with C. A. of 6, also has an M. A. of 6. The first boy's C. A. is greater.
110. The mean is that average above which and below which 50% of the scores fall.
111. A negative correlation is of the same value to the psychologist as a positive correlation of the same size.
112. Measures of any inherited trait tend to vary in the form of a normal curve.
113. Aptitude tests measure potential learning ability in a specific field.
114. An achievement quotient is related to the intelligence quotient.
115. The more intelligence one has, the better adjusted he will be in any vocation.
116. Individuals of the same age differ greatly in every trait that has been measured.
117. Low intelligence quotients tend to remain low or to become lower as age increases.
118. Traits of sibs correspond more closely than do those found in fraternal twins.
119. The greater the amount of white blood in Negroes, the higher the intelligence.
120. Full-blooded Indians make lower scores on intelligence tests than do Indians who have some 'white blood'.
121. Resemblance in mental traits increases in proportion to kinship.
122. Grouping together of children of the same chronological age in school is psychologically correct.
123. The I. Q. is an indicator of relative brightness.
124. A mental age of 6 means the level of mental development of an average child of six.
125. A chronological age of six is a safer basis for admitting children to the first grade than is a mental age of six.
126. Hallucinations are false perceptions.
127. Given a chance distribution of measures of any personality trait, one should expect a bell-shaped curve of distribution.
128. The normal person frequently has mild obsessions.
129. Individuals whose general scholastic averages are equal show approximately equal proficiency in all subjects.
130. The facial expressions of emotions of adults are more variable and less stereotyped than those of children.

.....SCORE
(Number of correct answers)

Scoring Key on Page xxxiii.

For interpretation of your score see Norms for Test III—Page xlii.

TEST IV

MULTIPLE CHOICE PROBLEMS ON PART B

In the following problems select the *best* answer and indicate your choice by printing the letter designating that answer on the line at the left of each problem. There is no time limit, but the test should require approximately 40 minutes. The score is the number of problems answered correctly. Remove test pages from book.

1. Free association is: (A) used in diagnosing emotional states (B) an important school of psychology (C) best used in working with aments (D) a product of the behavioristic influence in psychology.
2. The fact that training in mirror tracing with the right hand transfers to the left hand is called (A) transfer of training (B) cross education (C) formal discipline.
3. Stratton's experiment with inverted lenses shows for the sensitivity of vision, the effect of (A) relative size (B) distinctness (C) brightness (D) superposition (E) past experience.
4. Holt's Theory of Neurobiotaxis is a theory of (A) emotions (B) feelings (C) learning (D) motivation (E) taxonomy.
5. Which of the following is *not* a kind of insanity? (A) paresis (B) dementia praecox (C) paranoia (D) amentia (E) mania.
6. Carr postulated a theory of learning based on (A) frequency (B) recency (C) intensity (D) effect.
7. Thorndike explains learning in terms of two principles: 'effect' and (A) exercise (B) recency (C) frequency (D) intensity.
8. Learning differs from maturation in that (A) maturation is only acquisition (B) maturation is only reproduction (C) maturation is modification of reaction through previous practice (D) maturation is change in behavior through physiological growth.
9. Reinstatement of learning is known as (A) retention (B) recognition (C) reproduction.
10. I. E. ratio refers to (A) respiration (B) introversion-extroversion (C) intelligence (D) implicit emotion.
11. An electrocardiograph is a measure of: (A) blood pressure (B) electrical potential changes (C) skin resistance (D) glandular secretions.
12. When two motives are not in accord we always have a (A) neurosis (B) conflict (C) repression (D) phobia.
13. Morale is: (A) a practical problem of motivation (B) a cause of motivation (C) a hypothetical dream (D) dependent on social morale.
14. Emotion may be best judged by knowing (A) whether a subject is generally nervous (B) the stimulus (C) the quality and duration of the state (D) the glandular secretions.
15. Cannon's work with emotion was mainly a study of: (A) the striped muscles (B) heart action (C) glands of internal secretion (D) foetal kittens.
16. Watson concluded that one of the following was essential for maze learning. Which one? (A) vision (B) audition (C) olfaction (D) kinesthesis.
17. Who introduced the problem box experiment into Animal Psychology? (A) Watson (B) Thorndike (C) Kohler (D) Yerkes (E) Gesell.
18. Who introduced the nonsense syllable technique into experimental psychology? (A) Jones (B) Watson (C) Ebbinghaus (D) Wundt

19. Sudden decrease in time or in errors in a learning curve have been taken to indicate (A) trial-and-error learning (B) insight (C) completed learning (D) memory.
20. A test norm for any age is (A) the average score for children of that age (B) the highest score for that age (C) the lowest for that age (D) the range ratio for that age.
21. Sixty-eight percent of the men exceed the median of the women on reaction time tests. This means that (A) 68% of the men are better than 50% of the women (B) 18% of the men are better than 50% of the women (C) 32% of the men are better than 50% of the women.
22. Most of the general intelligence tests now in use stress (A) linguistic ability (B) mechanical ability (C) mathematical ability (D) social adaptation.
23. The first group test of intelligence was the (A) Pintner-Paterson (B) Stanford-Binet (C) Army Alpha (D) Otis Self-Administering (E) Kuhlman-Anderson.
24. What does the mental age of a child indicate? (A) his mental maturity (B) his rate of mental development (C) his brightness (D) his special abilities.
25. A correlation of—1.00 between card sorting and ability to solve multiple choice problems would mean (A) that those who did the best in one act did the best in the other (B) that there was no relation between the acts (C) that those who did the best in one act did the worst in the other.
26. A performance test means (A) a power test (B) a test not involving the use of language (C) a test of mechanical skill (D) a test of special abilities.
27. If some children of a very intelligent family were reared in a very poor environment the probable result would be (A) feeblemindedness (B) a slight decrease in I. Q. (C) a great change in I. Q. (D) no change in I. Q.
28. Which I. Q. indicates normal intelligence (A) 102 (B) 70 (C) 132 (D) 68 (E) 161
29. Which I. Q. indicates feeblemindedness? (A) 98 (B) 105 (C) 136 (D) 42 (E) 153.
30. In individual testing (A) the test is given as directed and takes no account of special conditions (B) literal form and established standards must be used but results are interpreted in the light of special conditions (C) no training is necessary if one reads from the directions given for the test (D) the examiner may force the subject to work.
31. Which of the following is the best intelligence test for the deaf (A) Pintner-Paterson (B) Stanford-Binet (C) Army-Alpha (D) Herring-Binet (E) Kuhlman-Anderson.
32. Assume two tests of general ability X and Y. Test X is better standardized than is test Y if (A) the items of X were more carefully selected than those of Y (B) X was applied to a number of highly selected groups of individuals, whereas Y was applied to a single heterogeneous group (C) if X was standardized by use of a larger number of unselected people than was Y (D) if individuals score higher on X than on Y.
33. A test to discover whether one would make a good plumber or not is called (A) an intelligence test (B) an aptitude test (C) a performance test.
34. Which type of test is probably the most valid for measuring general intelligence of most school children? (A) performance (B) group (C) Binet (D) aptitude.

35. Approximately what percent of the total population is feeble-minded? (A) twenty (B) ten (C) five (D) one.
36. The reliability of a test refers to (A) whether or not it measures what it is supposed to measure (B) whether it is consistent in measuring something (C) whether it is a speed or power test.
37. Which of the following instruments is used for measuring breathing changes? (A) sphygmomanometer (B) pneumograph (C) plethysmograph (D) sphymograph (E) psychogalvanometer.
38. Lange said that the major physiological change during an emotion was in the (A) smooth muscles (B) blood system (C) respiratory system (D) ductless glands (E) chiasma.
39. According to the James-Lange Theory, which of the following comes first (A) the emotion (B) the sensitivity of environmental stimulus (C) the sensitivity of internal turmoil (D) the explicit response to the stimulus.
40. During emotional states the "skin resistance" (A) is lower than during normal states (B) is often lower and often higher than during normal times (C) is higher than during normal times.
41. The secretion of adrenalin during emotions (using human subjects) was studied by (A) blood analysis (B) urine analysis (C) X-Rays (D) direct measurement (E) indirect measurement of overt activity.
42. The word association (free-association) test is used to discover (A) tonicity (B) complexes (C) amazement (D) empathy (E) glycosuria.
43. A study of judgment of emotions from facial expressions was done by (A) Watson (B) Cannon (C) Woodworth (D) Paterson (E) Feleky.
44. The distinction between fear and anger is based on differences in (A) native behavior (B) explicit activity (C) implicit activity (D) amount of adrenalin secreted.
45. When an actor expresses emotion he (A) merely allows his natural unlearned expressive movements to occur freely (B) reduces the natural expressive movements (C) uses characteristic modifications of natural expressive movements (D) builds up a new set of expressions.
46. Expectation of an electric shock results in (A) an increase in pulse rate (B) a decrease in pulse rate (C) in no change in pulse rate.
47. The inspiration-expiration ratio is (A) lower (B) higher (C) the same, before answering falsely to a question than after the answer has been given.
48. Introspective studies of emotion indicate that emotional awareness is (A) clear (B) recalled (C) disintegrative (D) speculative (E) nugatory.
49. Lloyd Morgan's Canon is a statement of opposition to (A) the law of belongingness (B) affective states in learning (C) anthropomorphism in interpretations (D) the James-Lange Theory (E) delayed response techniques in learning.
50. The "halo effect" refers to a constant error in (A) rating scales (B) learning experiments (C) intelligence tests (D) judgment of emotions from photographs (E) reaction time experiments.

. . SCORE
(Number of correct answers)

Scoring Key on Page xxxv.

For interpretation of your score see Norms for Test IV—Page xlu.

TEST V

MULTIPLE CHOICE AND COMPLETION PROBLEMS ON PART C—CHAPTERS X & XI

There is no time limit but this test should require about 40 minutes. The score is the number right.

Part I. Multiple Choice Problems.

Select the *best* answer and indicate your choice by printing the appropriate letter on the line at the left of the problem.

1. That after training neural impulses tend to follow one common pathway is the (A) wave motion theory (B) explosion fuse theory (C) electrical energy theory (D) drainage theory.
2. *Spinal ganglia contain (A) many cell bodies (B) synapses (C) cell* body of one neuron (D) efferent neurons.
3. The principal path of communication from higher to lower coordination centers is the (A) spinal lemniscus (B) pyramidal tracts (C) columns of Goll and Burdach (D) medial lemniscus.
4. In experiments the effect of continuous conduction of electric current by a nerve fiber is (A) failure to conduct (B) great resistance to current (C) no apparent effect (D) extreme fatigue.
5. The "motor area" is located in the (A) cuneas (B) ascending parietal convolution (C) superior temporal convolution (D) precentral gyrus.
6. The occipital lobe is (A) posterior (B) anterior (C) lateral (D) superior, to the parietal lobe.
7. That part of the brain which acts as a relay station for all afferent tracts (except the olfactory and vestibular) and passes these sensory impulses on to the cerebrum is the (A) cerebellum (B) precentral gyrus (C) thalamus (D) cuneas.
8. The function of the autonomic nervous system is (A) only excitatory (B) only inhibitory (C) both excitatory and inhibitory (D) important but unnecessary for life.
9. Goll's tract is in the (A) ventral (B) dorsal (C) lateral (D) commissural region of the spinal cord.
10. The term polarized neuron refers to (A) a difference in electrical potential between the two ends of the neuron (B) a neuron that will conduct in one direction only (C) a neuron connected in some way with a nerve net (D) a neuron of the central nervous system.

11. All neurons are similar in (A) polarity (B) shape (C) processes (D) size.

12. The fissure of Sylvius is located (A) between the occipital and parietal lobes (B) in the left cerebellar hemisphere (C) dorsal to the motor area (D) just above the temporal lobe.

13. "It is the great center for the proprioceptive reactions of the body much as the cerebrum is for the exteroceptive." The reference is to the (A) pons (B) thalamus (C) cerebellum (D) corpus callosum.

14. The pathway a nervous impulse takes through the nervous system is determined by (A) hippocampal convolutions (B) the length of the spinal cord (C) autonomic fibers (D) synaptic resistance.

15. The ascending tracts of the cord are mainly (A) sensory (B) motor (C) commissural (D) longitudinal.

16. The principal neural tract between the two cerebral hemispheres is (A) the pons (B) central commissure (C) corpus callosum (D) medial commissure.

17. The largest structure of the brain is the (A) cerebellum (B) pons Varolii (C) medulla oblongata (D) cerebrum.

18. The spinal cord becomes smaller toward the coccyx because (A) the spinal column is smaller (B) less strength is needed (C) fewer fibers and cell bodies are found at these levels (D) because the fibers are nearer the periphery.

19. The largest interlobular fissure of the brain is the (A) fissure of Rolando (B) parietal-occipital fissure (C) fissure of Sylvius (D) longitudinal fissure.

20. The structure of the brain which is thought to be most involved in the maintenance of bodily equilibrium is (A) the motor areas of the cerebrum (B) the cuneus (C) the cerebellum (D) the medulla.

21. The white matter of the brain looks different from the gray due to the presence of (A) myelin (B) synapses (C) bundles of fibers (D) cell bodies.

22. The cranial and spinal nerves form the (A) peripheral system (B) autonomic system (C) central system (D) cerebrospinal system.

23. The structural unit of the nervous system is the (A) synapse (B) reaction arc (C) axon (D) neuron.

24. The columns of Goll conduct impulses originating in the (A) exteroceptors (B) proprioceptors (C) interoceptors.

25. The hippocampal convolution is concerned with the sense of (A) touch (B) vision (C) hearing (D) taste.

Part II. Completion Problems.

The number of words necessary to complete each statement and make it true is indicated by the number in the parentheses. Write the word, or words, on the line at the right of each statement.

The spinal cord and the brain, taken as a whole, make up the (2).	26.
The white appearance of nerves is due to their (2).	27.
The four principal parts of a nerve cell are (1), (1), (1), and (2).	28. 29. 30. 31.
The functional juncture of two or more neurons is called a (1).	32.
Neurons are much branched or arborized at their ends. The arborized parts are called (2).	33.
Nervous impulses are said to vary in (1) and (1).	34. 35.
The functional unit of the nervous system is the (2).	36.
Peripheral nerves of the cerebrospinal system are divided into two classes of nerves, the (1) and (1).	37. 38.
The cord and the brain stem are composed of (2) and (1).	39. 40.
Below the *foramen magnum* the peripheral nerves enter the cord through the (2).	41.
The five lobes of the cerebrum are (1), (1), (1), (1), and (3).	42. 43. 44. 45. 46.
How many pairs of spinal nerves are there?	47.
Afferent impulses traverse fibers entering the (1) horn of the cord.	48.
A (1) or (1) is a collection of cell-bodies and their dendrites.	49. 50.

SCORE ..
(Number Right)

Scoring Key on Page xxxvii.
For interpretation of your score see Norms for Test V—Page xlvii.

TEST VI

ONE HUNDRED TRUE—FALSE PROBLEMS ON PART C—CHAPTERS XII TO XIV

If a statement is true, print a T on the line at the left of the statement; if false print an F. If a statement is partly true and partly false mark it as if it were entirely false. There is no time limit but this test should require approximately 40 minutes. The score is the number of statements correctly marked.

1. P-U's are unclear in dimensions.
2. Revery is a good example of controlled association.
3. Reasoning is a type of thinking.
4. The ratio of 1,000:1 represents the adaptation difference between rods and cones, in terms of the energy of the stimulus.
5. The ear is most sensitive (absolute threshold) for frequencies between 50 and 100 d.v. per second.
6. Color sensitivity is best explained by the Young-Helmholtz Theory.
7. Psychological activity, whether thinking or acting, is in relation to a goal.
8. The usual awareness is of immediate sensitivities only.
9. Affectivities have all the dimensions of sensitivities and hence affectivities are sensitivities.
10. Thinking is any sequence of directed awarenesses.
11. Mental set is a very clear or focal awareness.
12. 'Local sign' is a sort of unanalyzed motor reaction.
13. The existence of minimal laryngeal movements during thinking is evidence that the higher thought processes are localized in the vocal mechanism.
14. Immediate and recalled sensitivities differ only in intensity.
15. Recalled sensitivities represent a later stage in development than do the immediate sensitivities.
16. All environmental stimuli are equivocal in degrees in causing sensitivities or affectivities.
17. The law of the visual angle operates exactly in brightness sensitivity.
18. The average two-point threshold for the fovea has a subtended angle of 120 seconds.
19. Of all of the tastes the tip of the tongue is most sensitive to bitter.
20. Accomodation in vision is effective up to about 25 meters.
21. The horopteric circle includes all corresponding visual points in its circumference.

..... 22. Reports of awarenesses under the controlled conditions of an experiment are called reverses.

..... 23. Protensity indicates the magnitude or an awareness.

..... 24. Sensitivities may be classified as immediate or recalled.

..... 25. All psychological activity, whether thinking or acting, involves a succession of events.

..... 26. Contrast phenomena are unknown except in visual awarenesses.

..... 27. The two-point threshold is a measure of acuity or tactual space sensitivity.

..... 28. The less intense a sound or odor, the more distant the sensitivity is localized.

..... 29. Both attention and sensitivity are awarenesses.

..... 30. Weber's Law is a general statement of the relationship between intensity and protensity of sensitivity.

..... 31. Meaning is determined by recalled sensitivities in past experience.

..... 32. Postural sensitivities are not usually focal in awareness.

..... 33. Affectivity is awareness reported from the point of view of P-U.

..... 34. The absolute thresholds for cold and for warmth are greater than their differential thresholds.

..... 35. The most acceptable theory of sensitivity intensity is the volley theory.

..... 36. The Purkinje Phenomenon is due to a shift from tone to noise stimulation.

..... 37. Ladd-Franklin proposed a complementary color mixture theory.

..... 38. Unsaturated colors are more pleasant than saturated ones.

..... 39. Very high tones are more pleasant than very low tones.

..... 40. Attitudes are *non-affective* logical awarenesses.

..... 41. A positive after-sensitivity of red is red in color.

..... 42. Colored hearing is a form of synesthesia.

..... 43. Concrete images are the same as verbal images.

..... 44. The dimensions of affectivities are less differentiated than the dimensions of sensitivities.

..... 45. Prior to the age of six years, and prior to musical training, discords are liked as well as chords.

..... 46. Reasoning is not a trial-and-error process but is a straightforward analysis of a situation.

..... 47. Insight and abstraction are practically synonomous terms.

..... 48. The Heuristic Hypothesis states that affectivities are functions of sense-organ activities which are described as bright and dull pressures when S introspects on the sensitivities.

..... 49. FIGURE is to GROUND as PERIPHERY is to FOCUS.

..... 50. Perception involves meaningful sensitivities.

..... 51. Productive or creative imagination is found in dreams.

..... 52. Complex affective awarenesses are products of heredity.

..... 53. Concrete imagery develops with age and by most adults is used more than verbal imagery.

..... 54. There are wider individual differences in recalled sensitivities than in immediate sensitivities.

55. Surface color maintains its qualitative dimension, within limits of normal vision, upon changes in illumination.

. 56. The Duplicity Theory states that the only function of the rods is in achromatic vision.

57. The fovea is most sensitive (absolute threshold) for wave lengths of 554mμ under normal illumination.

58. Double images have a confusing effect on distance sensitivity.

59. The absolute threshold for pressure and pain spots vary in relation to their frequency.

60. Stationary 'visual movement' is dependent upon successive stimuli the rate for which is about 24 per second.

... 61. The absolute threshold for cold and warmth may be as low as 0.05° change from the adapted temperature of the cutaneous surfaces.

.. 62. Intensity of the sensitivity is always correlated exactly with the energy of the environmental stimulus.

.. 63. Helmholtz's Resonance Theory explains most of the conditions of peripheral auditory sensitivity.

64. A gradient theory is used to explain the differences in odor qualities.

65. The stimulus for pressure sensitivity is a ruptured nerve-ending.

. 66. Sensitivities grow in constancy in relation to the environmental stimuli.

67. The dimensions of sensitivities correlate exactly with the dimensions of the environmental stimuli.

68. Insight is the solution of a problem by thinking which does not depend upon past experience.

69. Quality is the name given to any single unitary awareness.

70. The different cutaneous qualities are explained by some authorities as due to quantitative differences in intensity.

71. The integration of sensitivities into meaningful wholes is not possible without past experience.

72. Recalled sensitivities may be uncorrelated with the immediate stimulus.

73. Thinking activities are restricted to the central nervous system.

74. Attending to pleasantness eliminates the pleasantness.

75. Interests are complex affective awarenesses.

76. P-U is always a strong motivating force.

77. A larger number of pleasant awarenesses are recalled than of unpleasant ones.

..... 78. P-U is a correlate of intensity of the sensitivity.

79. A congenital deaf-mute cannot learn to reason abstractly.
80. In the 'order of merit method' each stimulus is presented as one member of a pair of stimuli and the subject indicates which of the two he likes better.
81. Pleasantness and unpleasantness as related to any particular stimulus is largely due to training.
82. Symbolic response is an essential element in a great deal of thinking.
83. The report of the awareness situation is a full and complete statement of the psychological activity.
84. The 'order of merit method' is usually used in interest inventories.
85. With increase in age the affective awarenesses become more stable or constant for the same stimuli.
86. Visual hues at the ends of the spectrum are usually more pleasant than those in the middle.
87. There are no differences in the affective awarenesses for different odors.
88. Awareness is a source of information in understanding psychological stimulation.
89. Sensitivities are immediate awarenesses correlated with environmental stimuli.
90. Both perceptual and ideational awarenesses include recalled sensitivities.
91. Higher psychological processes, such as thinking, involve only higher nervous centers.
92. Ability to state an opinion indicates that reasoning behavior has been used in connection with the problem.
93. The faintest visual sensitivity is just perceptible above self-light.
94. Contrast effects are not present when different brightnesses or different saturations are presented separately to the two eyes.
95. Movement and change of stimuli are effective determiners of the direction of attention.
96. Intensity of stimuli is an important determinant of attention.
97. Illusions are errors of perception.
98. Only one object or event can be attended to at one time.
99. There is usually a detailed awareness of intent in the mid-period of the task.
100. Hering postulated four separate receptors for color vision.

. . . . . SCORE
(Number Right)

Scoring Key on Page xxxix.

For interpretation of your score see Norms for Test VI—Page xliii.

SCORING KEY FOR TEST I—PAGE iii.

Consult the directions for scoring on page i. Acceptable alternates are included in parentheses. This page is perforated and may be detached for ease in scoring.

1. Nervous
2. Muscle fibre
3. Striped muscles (Striated muscles)
4. Nervous system
5. Striped (Striated)
6. Smooth (Unstriated)

any order
7. Motor end plate
8. Muscle fibre

9. Cells (Fibers)
10. Unit (Whole)
11. Receptors
12. Circulatory system (Blood stream)
13. Environmental changes (Energy changes)
14. Receptors

any order
15. Sensitivity
16. Reaction
17. Integration
18. Learning (Development)

any order
19. Explicit
20. Implicit

21. Interoceptors
22. Blind spot (Optic disc)
23. Observer (Subject)

any order
24. Audition
25. Vision

any order
26. Sweet, Sour
27. Salt, Bitter

28. Physiological zero
29. Reaction (Response, Behavior)

any order
30. Exteroceptors
31. Interoceptors
32. Proprioceptors

33. Lens
34. Taste buds (Taste cells)
35. Free nerve endings
36. Oval window (Fenestra ovalis)
37. Adaptation (Fatigue)
38. Rods
39. Cutaneous pressure
40. Combination tone (Difference or Summation tone)
41. 10 to 20

any order
42. Intensity
43. Protensity (Duration)
44. Extensity

any order
45. Hue (Chroma)
46. Brightness (Brilliance)
47. Saturation

any order
48. Pitch
49. Octave (Tonality)
50. Volume

SCORING KEY FOR TEST II—PAGE v.

Consult the directions for scoring, page i.

1. T
2. F
3. T
4. T
5. F
6. T
7. F
8. F
9. F
10. F
11. T
12. T
13. F
14. T
15. F
16. F
17. T
18. T
19. T
20. F
21. F
22. F
23. T
24. F
25. T
26. T
27. T
28. F
29. F
30. F
31. T
32. F
33. T
34. T
35. F
36. F
37. T
38. F
39. F
40. F
41. F
42. F
43. T
44. T
45. F
46. T
47. F
48. T
49. F
50. T
51. F
52. T
53. T
54. T
55. F
56. T
57. F
58. T
59. T
60. F
61. T
62. T
63. T
64. F
65. T
66. F
67. T
68. F
69. T
70. T
71. T
72. T
73. T
74. F
75. T
76. F
77. T
78. T
79. T
80. T
81. F
82. F
83. F
84. T
85. F
86. T
87. T
88. T
89. F
90. T
91. T
92. T
93. F
94. T
95. F
96. T
97. F
98. T
99. F
100. T
101. T
102. F
103. T
104. F
105. T
106. F
107. T
108. T
109. F
110. T
111. F
112. F
113. F
114. T
115. T
116. T
117. F
118. T
119. T
120. T
121. F
122. T
123. F
124. F
125. T
126. T
127. F
128. T
129. F
130. T
131. F
132. F
133. F
134. F
135. F
136. F
137. F
138. T
139. T
140. F
141. F
142. T
143. T
144. T
145. T
146. F
147. T
148. F
149. F
150. T

SCORING KEY FOR TEST III, PAGE xi.

Consult the directions for scoring, page i.

1. T
2. F
3. F
4. T
5. F
6. T
7. T
8. T
9. T
10. T
11. T
12. F
13. T
14. F
15. T
16. T
17. T
18. F
19. F
20. T
21. T
22. T
23. F
24. F
25. F
26. F
27. T
28. T
29. F
30. F
31. T
32. F
33. F
34. F
35. T
36. F
37. T
38. F
39. T
40. T
41. F
42. T
43. F
44. T
45. T
46. F
47. F
48. T
49. T
50. F
51. F
52. T
53. T
54. F
55. F
56. T
57. F
58. F
59. T
60. T
61. F
62. F
63. T
64. F
65. F
66. T
67. F
68. F
69. F
70. T
71. T
72. F
73. F
74. T
75. T
76. T
77. F
78. F
79. T
80. F
81. T
82. F
83. T
84. F
85. F
86. T
87. T
88. F
89. F
90. F
91. F
92. T
93. F
94. T
95. T
96. F
97. T
98. T
99. F
100. F
101. F
102. F
103. F
104. F
105. T
106. F
107. T
108. T
109. F
110. F
111. T
112. T
113. T
114. T
115. F
116. T
117. T
118. F
119. T
120. T
121. T
122. F
123. T
124. T
125. F
126. T
127. T
128. T
129. F
130. F

SCORING KEY FOR TEST IV, PAGE xvii.

Consult the directions for scoring, page i.

1. A
2. B
3. E
4. C
5. D
6. C
7. A
8. D
9. C
10. A
11. B
12. B
13. A
14. B
15. C
16. D
17. B
18. C
19. B
20. A
21. A
22. A
23. C
24. A
25. C
26. B
27. B
28. A
29. D
30. B
31. A
32. C
33. B
34. C
35. D
36. B
37. B
38. B
39. B
40. B
41. A
42. B
43. E
44. B
45. C
46. A
47 A
48. C
49. C
50. A

KEY FOR TEST V, PAGE xxi.

Consult the directions for scoring on page *i*. Acceptable alternates are included in parentheses. This page is perforated and may be detached for ease in scoring.

1. D
2. A
3. B
4. C
5. D
6. A
7. C
8. C
9. B
10. B
11. A
12. D
13. C
14. D
15. A
16. C
17. D
18. C
19. C
20. C
21. A
22. A
23. D
24. B
25. D

26. central axis
27. myelin sheath (medullary sheath)

any order:
28. axon
29. dendrite
30. nucleus
31. cell body

32. synapse
33. end brushes

any order:
34. intensity
35. frequency

36. reflex arc (reaction arc)

any order:
37. cranial
38. spinal

any order:
39. projection centers
40. ganglia (nuclei or centers)

41. intervertebral foramen

any order:
42. frontal
43. temporal
44. parietal
45. occipital
46. Isle of Reil

47. 31
48. dorsal

any order:
49. ganglion
50. center (nucleus)

SCORING KEY FOR TEST VI, PAGE xxv.

Consult the directions for scoring, page i.

1. T
2. F
3. T
4. F
5. F
6. T
7. T
8. F
9. F
10. T
11. F
12. F
13. F
14. F
15. T
16. T
17. F
18. F
19. F
20. F
21. T
22. F
23. F
24. T
25. T
26. F
27. T
28. T
29. T
30. F
31. T
32. T
33. T
34. F
35. T
36. F
37. F
38. F
39. F
40. F
41. T
42. T
43. F
44. T
45. T
46. F
47. F
48. T
49. F
50. T
51. T
52. F
53. F
54. T
55. T
56. T
57. T
58. F
59. T
60. T
61. T
62. F
63. T
64. F
65. F
66. T
67. F
68. F
69. T
70. T
71. T
72. T
73. F
74. T
75. T
76. F
77. T
78. T
79. F
80. F
81. T
82. T
83. F
84. F
85. T
86. T
87. F
88. T
89. T
90. T
91. F
92. F
93. T
94. F
95. T
96. T
97. T
98. T
99. F
100. F

PERCENTILE NORMS FOR TEST I—PAGE iii.

The following norms were established upon college sophomores after they had studied Part A in a course in general psychology.

Highest Score						47	
90%ile (90%	made	scores	less	than)		39	
80%ile (80%	"	"	"	")		36	
70%ile (70%	"	"	"	")		34	
60%ile (60%	"	"	"	")		32	
50%ile (50%	"	"	"	")		31	The Median Score
40%ile (40%	"	"	"	")		30	
30%ile (30%	"	"	"	")		28	
20%ile (20%	"	"	"	")		24	
10%ile (10%	"	"	"	")		20	
Lowest Score						17	

PERCENTILE NORMS FOR TEST II—PAGE v.

The following norms were established upon college sophomores after they had studied Part A in a course in general psychology.

Highest Score						133	
90%ile (90%	made	scores	less	than)		120	
80%ile (80%	"	"	"	")		116	
70%ile (70%	"	"	"	")		113	
60%ile (60%	"	"	"	")		110	
50%ile (50%	"	"	"	")		107	The Median Score
40%ile (40%	"	"	"	")		104	
30%ile (30%	"	"	"	")		102	
20%ile (20%	"	"	"	")		99	
10%ile (10%	"	"	"	")		97	
Lowest Score						83	

PERCENTILE NORMS FOR TEST III—PAGE xi.

The following norms were established on college sophomores after they had studied Part B in a course in general psychology.

Highest Score	110	
90%ile (90% made scores less than)	101	
80%ile (80% " " " ")	97	
70%ile (70% " " " ")	93	
60%ile (60% " " " ")	90	
50%ile (50% " " " ")	87	The Median Score
40%ile (40% " " " ")	84	
30%ile (30% " " " ")	80	
20%ile (20% " " " ")	75	
10%ile (10% " " " ")	71	
Lowest Score	41	

PERCENTILE NORMS FOR TEXT IV—PAGE xvii.

The following norms were established on college sophomores after they had studied Part B in a course in general psychology.

Highest Score	41	
90%ile (90% made scores less than)	37	
80%ile (80% " " " ")	34	
70%ile (70% " " " ")	32	
60%ile (60% " " " ")	30	
50%ile (50% " " " ")	29	The Median Score
40%ile (40% " " " ")	27	
30%ile (30% " " " ")	26	
20%ile (20% " " " ")	24	
10%ile (10% " " " ")	21	
Lowest Score	16	

PERCENTILE NORMS FOR TEST V—PAGE xxi.

The following norms were established on college sophomores after they had studied Part C in a course in general psychology.

Highest Score	45	
90%ile (90% made scores less than)	37	
80%ile (80% " " " ")	34	
70%ile (70% " " " ")	32	
60%ile (60% " " " ")	31	
50%ile (50% " " " ")	28	The Median Score
40%ile (40% " " " ")	26	
30%ile (30% " " " ")	24	
20%ile (20% " " " ")	22	
10%ile (10% " " " ")	20	
Lowest Score	16	

PERCENTILE NORMS FOR TEST VI—PAGE xxv.

The following norms were established on college sophomores after they had studied Part C in a course in general psychology.

Highest Score	93	
90%ile (90% made scores less than)	89	
80%ile (80% " " " ")	84	
70%ile (70% " " " ")	80	
60%ile (60% " " " ")	77	
50%ile (50% " " " ")	72	The Median Score
40%ile (40% " " " ")	68	
30%ile (30% " " " ")	61	
20%ile (20% " " " ")	53	
10%ile (10% " " " ")	47	
Lowest Score	23	